TM 55-1263

DEPARTMENT 0F THE ARMY TECHNICAL MANUAL

LOCOMOTIVE DIESEL ELECRIC

56 ½ GAGE
65 TON, 0-4-4-0, 400 HP
GENERAL ELECTRIC
CUMMINS ENGINE
MODEL HBIS-600

DEPARTMENT OF THE ARMY *MARCH 1955*

TECHNICAL MANUAL
No. 55-1263

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LOCOMOTIVE, DIESEL ELECTRIC, 56 ½" GAGE, 65 TON, 0-4-4-0, 400 HP, GENERAL ELECTRIC, CUMMINS ENGINE MODEL HBIS-600

		Paragraphs	Page
CHAPTER 1. INTRODUCTION			
Section I.	General	1-3	3
II.	Description and Data	4,5	4
CHAPTER 2. OPERATION			
Section I.	Preliminary Instructions	6-10	6
II.	Preliminary Operation	11-16	7
III.	Starting and Stopping	17,18	8
IV.	Operation of Locomotive	19-32	8
V.	Simple Troubles	33,34	10
VI.	Inspection	35-41	11
CHAPTER 3. MAINTENANCE			
Section I.	General	42-47	13
II.	Lubrication	48-57	14
III.	High Potential Tests	58-60	16
IV.	Power Plant and Locomotive Throttle Control Tests and Adjustments	61-69	17
V.	Traction Generator	70-80	25
VI.	Traction Motor Type GHM-838-D1-250 Volt Motor	81-94	35
VII.	Control Equipment	95-106	43
VIII.	Type 2022-G or 2023-G Generator	107-111	55
IX.	Generator Control Unit Type 1800-R16, Regulator	112-115	57
X.	Battery Instructions	116-121	61
XI.	Kerosene Burning Water Heaters	122-131	62
XII.	Trucks and Running Gear	132--153	65
INDEX			81

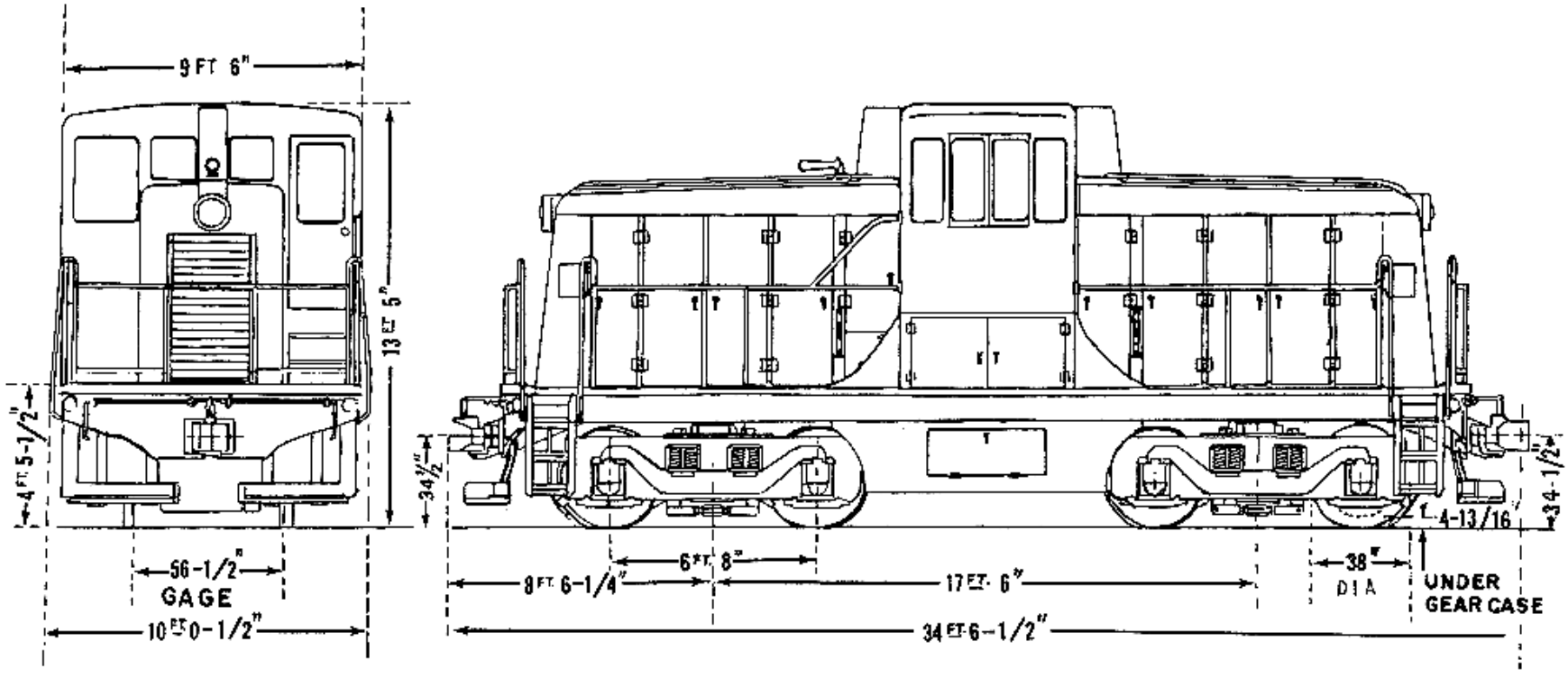


Figure 1. Locomotive outline.

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1. Scope

This manual is published for the information and guidance of the personnel concerned with the operation and maintenance of General Electric 65Ton, 400 HP, Diesel Electric Locomotive, providing information and instructions for carrying out their duties and discharging their responsibilities. This manual outlines procedures for necessary inspection and proper maintenance by trained personnel familiar with locomotive construction and repairs.

2. References

a. DA Supply Manual TC 7 & 8 L-37, Organizational Maintenance Allowances and Field and Depot Maintenance Stockage Guide, Locomotive, Diesel--Electric 56 1/2" Gage, 65-Ton, 0-4-4-0,400 HP, General Electric (TC Stock No. 58-4991-05-824).

b. TM 55-270, Operation of Railroads, General Instructions for the Inspection and Maintenance of Locomotives and Locomotive Cranes.

c. TM 55-271, Operation of Railroads, Diesel--Electric Locomotives.

d. TM 55-405, Preventive Maintenance of Electric Motors and Generators.

e. TM 55-1001, Instruction Manual and Parts List for Operation and Maintenance of Cummins Diesel Engines for U. S. Army Transportation Corps Contract W-2789 TC.

f. LO 55-1001, Generator Set, Diesel Engine - Driven (Cummins Models H, HI, HBI, HBIS 600).

g. LO 55-1263, Locomotive, Diesel-Electric, (General Electric 65 Ton Engine-Cummins Model HBIS-600).

h. TM 55-2021, Brake Equipment No. 14-EL for Diesel-Electric Switching Locomotives (Westinghouse Air Brake).

3. Standard Forms and Records

a. DD Form 438-1, Railway Equipment Report, Motive Power Other Than Steam, Part I-Registry, Assignment and Service Record (Cut Sheet).

b. DD Form 438-5, Railway Equipment Report, Part II-Semi-Annual Service and Maintenance (Cut Sheet).

c. DA Form 55-115, Daily Assignment Worksheet for Locomotives and Locomotive Cranes (Cut Sheet).

d. DA Form 55-226, Daily Inspection Report Locomotives and Locomotive Cranes (Cut Sheet). *e.* DA Form 55-230, Monthly Inspection and Repair Report of Locomotives and Locomotive Cranes other than Steam (Cut Sheet).

f. DA Form 55-235, Locomotive Inspection, Cleaning and Test Record (Cut Sheet).

g. DA Form 55-236, Locomotive Specifications Card (Card).

h. DD Form 70, Daily Inspection Work Sheet for Diesel Locomotives (Cut Sheet).

i. DD Form 71, Monthly Inspection Work Sheet for Diesel Locomotives, (Parts 1 & 2) (Set).

j. DD Form 72, Quarterly Inspection Work Sheet for Diesel Locomotives (Parts 1 & 2) (Set).

k. DD Form 73, Semi-Annual Inspection Work Sheet for Diesel Locomotives (Parts 1 & 2) (Set). l. DD Form 74, Annual Inspection Work Sheet for Diesel Locomotives (Parts 1 & 2) (Set).

m. DA Form 55-154, Record of Special Test Made On Air Brake Equipment (Cut Sheet).

4. General

This locomotive has two Cummins Model HBIS600 Diesel Engines, each nominally rated 200 hp at 1800 rpm. Each engine is direct connected through a flexible disc coupling to a General Electric Type GT-588, direct current, shunt wound, generator. Each complete engine-generator set, which is supported on a subbase mounted on the locomotive underframe, supplies electrical energy to the traction motors. The generators are equipped with windings for use in starting the engine by storage battery power. When the engines are shut down, auxiliary power is supplied by one 16-cell, lead acid type battery which is recharged by two auxiliary generators, one mounted on each engine. The auxiliary power is furnished at a constant potential over the full operating range of engine speed. The locomotive has four General Electric Type GHM838, direct-current, series wound, totally enclosed traction motors. The motors deliver power to four axles, individually through single reduction spur gearing with a ratio of 5.062:1. Each motor is axle mounted and spring supported from the truck frame. The air brake equipment is combined straight and automatic, schedule 14-EL, with one engineer's valve, Type K-14. Two brake cylinders mounted on each truck operate fully equalized brake rigging, applying one shoe to each wheel. A ratchet and drop lever type hand brake is provided for holding the locomotive at a standstill. There are two air-cooled, two-stage, belt-driven air compressors suitable for operating against a reservoir pressure of 100 pounds. The piston displacement of each compressor is 50 cubic feet per minute when operating at a speed corresponding to the full load speed of the engine. The capacity of the main air reservoir is approximately 43,000 cubic inches. The locomotive is equipped with General Electric single station, single-unit control. The operator's station is placed on the right-hand side of the cab. Grouped at this station are the throttle lever, reversing lever, brake lever, sander valve, bell and horn controls, window wiper controls, engine start switches, gage panels, and tumbler switches for controlling lights. Accessories applied to the locomotive include four air-operated sanders, bell horn, two headlights, two cab heaters, and two window wipers.

5. Component Data

a. Locomotive.

Manufacturer	General Electric
Classification	B-B-130/130
Specification	RY -24149-B
Total nominal weight	130,000 pounds
Traction effort (30% adhesion)	39.000 pounds
Minimum radius of curve	75'
Maximum permissible speed	40 mph
Control	Single station, single unit
Fuel capacity	250 gallons
Lube oil capacity	5 gals per engine
Cooling system capacity	5 gals per engine
Driving coupling	Traction motor to axle
Gear ratio	5.062:1
Height overall	13' 4 1/s"
Length overall	34' 0"
Width overall	10' 1 1/2"
Wheel base overall	24' 2"

b. Engine.

Manufacturer	Cummins
Model	HBIS-600
GE specifications	K-6723352AO-AHAK
Type	Supercharged, cast en-bloc, valve in head.
Cylinders	6
Bore	4 7/8”
Stroke	6"
Displacement	672 cubic inches
HP rating	20 hp at 1800 rpm
Fuel system	Solid injection
Weight	2540 pounds

c. Main Generator.

Manufacturer	General Electric
Type	GT-558
Specification	RY-16289-A
Volts	260 at 1800 rpm
Amperes	420 at 1800 rpm
Weight	1900 pounds

d. Traction Motor Data.

Manufacturer	General Electric
Type	GHM-838
Specification	RY-22017-A

Volts	250
Amperes	410
Weight	4660 pounds

e. Brake Equipment.

Manufacturer	Westinghouse Air Brake
Schedule	14-EL

f. Truck.

Manufacturer	General Electric
Wheel type	Solid roll steel
Wheel arrangement	0-4-4-0
Diameter	38" (AAR Contour)
Truck wheel base	6' 8"
Truck centers	17' 6"

CHAPTER 2

OPERATION

Section I. PRELIMINARY INSTRUCTIONS

6. Battery

a. To maintain a satisfactory state of charge in the battery and to realize good battery life, observe carefully the battery- instructions, paragraphs 116 through 121.

b. An electric meter is provided on a gage panel for the purpose of allowing the engineer to observe that the charging generators are functioning and that the battery is being charged.

c. When a voltmeter is used for this purpose, if the needle is in the first long RED band it indicates that the battery is in bad condition or being discharged. When the needle is in the WHITE band, it indicates that the battery is neither being charged nor discharged. The needle in the GREEN band is an indication that the battery is receiving a normal charge. When the needle is in the small RED band beyond the GREEN, it indicates that the battery is being overcharged. The engine crew should report to the maintenance man when the voltmeter indicates in the RED band of the dial.

Note. The pointer may be in the WHITE band just below the GREEN band for a short time after the engines are first started.

d. An ammeter, when used, also indicates the condition of the battery. Generally the amount of current shown on the charging portion of the dial is proportional to the state of charge of the battery. As the pointer approaches zero, the battery gets nearer to fully charged condition. When the pointer is in discharge portion of the dial, the battery is delivering instead of receiving current. When this condition exists under normal operation, it should be reported to the maintenance man. It should be noted that neither voltmeter nor ammeter will show the condition of the battery unless the charging voltage for normal operation is at such value as to maintain the battery at proper charge.

e. To protect the battery against discharge and short circuits, the locomotive is shipped with the 6

ground connection removed from the battery. This must be restored before putting the locomotive in service.

7. Battery Switch

a. This switch is provided for disconnecting the battery from the circuits and must always be opened when leaving the locomotive for an idle period. It must also be opened whenever working on any control circuits.

b. If necessary to work on any of the circuits or devices not protected by a cutout switch, the ground must be removed from the battery.

8. Control Switches

To prevent battery discharging, be sure that all switches in circuits which the battery supplies current for are open when leaving the locomotive standing idle.

9. Throttle or Controller Handle

a. Always leave the throttle handle or the controller handle in that position which will insure that the traction motors will remain disconnected from the' generators whenever the engines are started to prevent accidental starting of the locomotive.

b. Never leave the operating position without first placing the reverser handle in the neutral position. If the reverser handle is the portable type, remove it for further protection.

10. Load Indicator-Service and Load-Time Limits

a. This locomotive is designed for switching and transfer moves not exceeding 1/2 hour's continuous duration at full power. The following load-time limits apply only for such service.

b. The locomotive is not intended for railway road work, long transfer, or long industrial haulage service. It can be damaged if very heavily loaded for too long a time. Such damage is caused by heating which depends upon the length of time the load is carried as well as the size of the load. c. A load indicator, when used, is actually an ammeter with a special dial marked in bands of GREEN, YELLOW, and RED, instead of amperes. The load indicator will enable the operator to avoid damaging the locomotive if the following rules are observed:

(1) GREEN-Operation with the pointer in the green is unrestricted as long as the locomotive is employed in the service for which it was designed as described above.

(2) YELLOW-Operation with the pointer in the yellow must not exceed 1 hour total in any 8-hour period.

(3) RED-Operation with the pointer in the red should be confined to starting or short movements that are never over 4 minutes at a time. When the time in the red is 2 minutes or more, the operation should not be repeated frequently.

d. The total time in the red and yellow added together must not exceed 1 hour in any 8-hour period.

e. When starting a train, the operator should not hesitate to go into the red and advance the throttle as far as possible without slipping the wheels. In this way the time in the red will be kept to a minimum.

Section II. PRELIMINARY OPERATION

11. Speed

Caution: Do not operate the locomotive at any higher speed than that given under locomotive data.

12. Diesel Engines

a. Before starting the engines and before doing any work on them, read the engine instructions, TM 55-1001, to be sure that the engines are in operating condition.

b. While operating the engines, make regular check of lubricating oil pressures and cooling water temperatures.

c. If the engines become overheated for any reason, never add water to the cooling system until the engines have cooled off.

d. After pulling heavy loads, allow the engines to idle for a few minutes before stopping them to prevent the danger of boiling the cooling water.

13. Brakes

a. Never depend upon the air brakes to hold the locomotive on a grade when the compressors are shut down.

b. Before starting the locomotive, make sure the brakes operate properly and that the air pressure in the reservoir is normal.

c. In emergencies, apply the brakes at once and shut off the power afterwards.

d. Engineers operating the locomotive for the first time should be cautioned to apply the brakes sooner than they would on a steam locomotive in order to stop at a given spot. This is because an electric locomotive has much less friction than a steam locomotive.

14. Leaving the Locomotive

a. Before leaving the locomotive, shut down the engines, open all the switches, and see that all doors and windows are closed.

b. Close radiator shutters.

c. Set the hand brakes.

d. If there is danger of the engine cooling water freezing, drain the entire cooling system unless antifreeze is used.

15. Water and Lubricating Oil

Before starting the engines, be sure the water systems are filled. Also, see that each engine is supplied with the proper quantity of suitable lubricating oil.

16. Lubrication

Before starting the engines and before running the locomotive, read the lubrication instructions for the engines and compressors; also, refer to the locomotive LO 55-1001 (fig. 49) and 55-1263 (fig. 50) to be sure that all parts have been properly lubricated.

Caution: Do not reach inside the frames of generators or motors while they are in operation.

Caution: Do not leave tools or any other loose material near the electrical equipment when the locomotive is in operation.

Section III. STARTING AND STOPPING

17. Starting Power Plant

a. Before attempting to operate the locomotive for the first time, observe all of the foregoing preliminary instructions and the instructions on the engines and other equipment.

b. Close the battery and control switches.

c. See that the reverse handle is in neutral position and the throttle handle in idling position. (In cold weather it may be necessary to advance the throttle beyond the idling position to get the engines started.)

d. Start each engine by pushing the start button for the respective engines and observe that each engine operates properly and that the lubricating oil pressure builds up.

e. Allow the compressors to pump air until the main reservoir air gage shows no further increase in pressure. See that the compressors function properly.

f. To pump up air quickly, advance the throttle handle to operate the engines at about three-fourths speed, but first allow the engines to operate at idling speed a sufficient length of time to warm up. Reduce the engine speed to idling when finished pumping up air.

g. Observe the operation of all belt drive machines and other equipment to see that they function properly.

h. Apply the air brakes to see that they operate properly.

i. See that the battery is being charged as indicated by the battery meter.

j. Diesel electric locomotives operating in cold climates are provided with a heater to warm up the engine before starting.

k. The diesel engine has no ignition system and depends upon the heat developed by compression to make it fire. Therefore, after periods of shutdown during cold weather where the engine has cooled down to air temperature, there is danger of completely discharging the battery by continued cranking before the cylinders get warm enough to start. To guard against this condition, a kerosene heater is provided for the purpose of warming up the cooling water in the engine jacket.

l. To start this heater, make sure that there is sufficient kerosene in the supply tank. Open the valve in the line between the top of the water heater and the engine water jacket. This valve should be closed when the engine is operating. A thermostat shuts off the water circulation to the radiator.

m. Light the wick and adjust for a clear blue flame. Readjust, if necessary, after the heater has warmed up to avoid smoking.

n. Do not attempt to start the engine until the engine temperature shows at least 60° or 70° on the engine temperature indicator.

o. After the engine starts, shut down the heater and close the valve to the engine cooling system.

18. Stopping Engines

a. To stop the diesel engine, move the throttle into the extreme forward position.

b. If the locomotive is provided with engine shutdown rods, also pull the button marked engine shutdown and hold it until the engine has come to a stop, then open the control switch.

c. If at any time an engine fails to stop under normal conditions, or if it overspeeds, pull the emergency shutoff pull button, or close the shutoff cock, on the side of the fuel pump, if the engine is provided with these features.

d. If the throttle valve should stick in open position, close it by hand.

Section IV. OPERATION OF LOCOMOTIVE

19. General

a. It is assumed that the locomotive has been made ready to operate in accordance with the foregoing instructions and that the engines are operating and the main reservoir is fully charged. If at any time it is impossible to remove power from the traction motors by shutting off the throttle, the control switch should be opened.

b. Before attempting to start the locomotive, be sure that the hand brake is released. Move the reverser handle to forward or reverse position as desired. When the throttle handle is then advanced,

certain control circuits are energized which closes the line contactors and establishes connection between the traction motors and generators. Increased current through the traction motors, or acceleration of the locomotive is then obtained by advancing the throttle handle. Shunting connections of the traction motor fields are automatically established at the proper point.

c. In order to change the direction of motion of the locomotive, the throttle handle should be placed in position for idling the engines and the locomotive brought to a stop before the reversing handle is moved. The locomotive should never be reversed while in motion except in cases of extreme emergency.

d. When there is a tendency for the wheels to slip, the rails should be sanded and the throttle closed slightly until the wheels stop slipping. In case the wheels lose their grip entirely and spin, it is usually necessary to move the throttle into idling position before the wheels take hold.

e. When coming to rest on a grade, the brakes should be applied on the locomotive before closing the throttle handle. Likewise, when starting on an ascending grade, do not release the brake of the locomotive until the throttle handle has been opened to a sufficient amount to prevent the train, or locomotive, from drifting backward.

f. If the current fails on the locomotive for any reason, close the throttle handle and, if on a grade, apply the brakes.

g. DO NOT OPERATE THE LOCOMOTIVE AT HIGHER SPEED THAN 40 MPH.

20. Overheating Engines

a. Do not stop the engines immediately after a hard run. Circulation of the water depends upon the circulating pump and when the engines are shut down, the pumps also stop. The iron masses in an engine pulling full load absorb sufficient heat to boil the water if the circulation stops. Let the engines idle for 5 minutes before shutting them down.

b. If for any reason the water supply has failed, do not turn water into the cylinders until they have become normally cool.

c. The heads are liable to crack if they have become too hot and water is turned into them.

21. Operation with One Power Plant Only

a. The locomotive may be operated at any time TAGO 3747-A, Feb. with one power plant simply by leaving the other plant shut down.

b. Proper precautions should be taken so water in the shutdown engine does not freeze.

22. Operation with Motors Cut Out

In case of trouble making it necessary to cut out a traction motor, shut down engine furnishing power to the motor. With motors cut out, special care should be taken to avoid pulling heavy loads or operating with full open throttle.

23. Operation of Air Brake

For operation of air brakes, refer to TM 55-2021.

24. Moving Locomotive Dead

a. When the locomotive is hauled dead in a train, all switches should be opened including the battery cutout switch. The air brake dead-engine fixtures should be set as described in the TM 55-2021.

b. If the haul is long, or the train speed exceeds the maximum safe speed of the locomotive, remove the pinions from the traction motors. Refer to pinion removal, paragraph 87.

25. Compressors and Other Auxiliary Machines

a. The compressors and other auxiliary machines are driven by V belts from the generator. Adjustments of the belt tension are provided for by moving these machines on their bases so as to change the distance between pulley centers.

b. A fairly accurate guide for determining the correct tension on the belts is to make the adjustment so that the belts can be depressed about 1 inch at a point midway between the pulleys.

26. Temperature Control of Cooling Water

a. Diesel engines have the fans belted directly to the engines and are provided with a thermostat in the cooling water outlet which permits the water to circulate through the engine cylinder block and shuts it off from the radiator when the temperature of the water in the engine is below that for which the thermostat is set.

b. During cold weather it may be necessary to partly or entirely close the shutters in front of the radiators in order to maintain the proper temperature.

c. The control levers in the operating cab are marked to show the position of the radiator shutters.

d. If it becomes difficult to operate the shutters, it is very likely caused by lack of lubrication at the hinge pins of the vanes and at the operating lever pin joints. For lubricant, use a light oil especially during cold weather.

27. Battery Charging Equipment

a. In general, the function of the auxiliary generators, or charging generators, is to supply the control and the lighting load and also to charge the batteries. On locomotives with more than one power plant, the generators are connected in parallel for battery charging.

b. The battery charging equipment for each power plant consists of a voltage regulator and reverse current relay and a generator mounted on the engine and driven there from by gearing.

28. Engine Starting Equipment

In this type of starting, the traction generator is used as a motor. To facilitate starting without excessive drain on the battery, the generator is provided with a series field winding.

29. How Power Is Obtained

a. The engine supplies mechanical power to the generator which is converted to electrical power for the traction motors and auxiliaries. Each engine and its respective generator is at all times electrically, as well as mechanically, an independent power plant unit.

b. The control is so arranged that opening the throttle at the operator's position increases the speed of the engine or engines. This increases the power furnished the generator which furnishes
the power for the traction motors. The throttle adjustment should be maintained so that each engine, when in good condition, takes its power share of the load.

30. Main Circuits

a. The main circuits for each power plant include the following equipment: Traction generator, traction motors, contactors for connecting the traction generator and traction motors, and a reverser for changing the direction of current in the traction motor fields.

b. Across the traction motor field is connected a field shunting resistance which is used for weak field operation at the higher locomotive speeds in order to obtain maximum engine utilization over a wide range of locomotive speeds.

31. Generator Field

The shunt field is supplied with current furnished by the generator itself, but may also receive part of its exciting current from the battery depending on the scheme of connections.

32. Precautions

a. Do not leave the locomotive unless the engines are shut down. See that the battery cutout switch and control switch are open. Close all windows and doors. Set the hand brake.

b. When locomotive is standing idle, and engines are to remain shut down and there is any danger of the engine water temperature falling below freezing, the system should be completely drained unless antifreeze is used.

Section V. SIMPLE TROUBLES

Refer to locomotive connection diagram, figure 48.

33. Failure of Engine to Turn Over

a. Make sure the battery and control switches are closed.

b. Then see that the starting contactor GS1 or GS21 closes. If it does not close, check battery and control fuses and replace same if blown. If the starting contactor still does not close, check for open circuit at starting button or at the control switch, or at the operating coil of the starting contactor.

c. If the starting contactor operates, but still the engine will not turn over, the starting contactor main connections may be defective, or the battery is probably discharged and should be recharged from an outside source.

d. If the battery is not discharged and still the engine can not be started, the generator is probably at fault, the most likely trouble being poor ground connection, or burned out or loose connections in the main circuit.

34. Engine Started, Locomotive Will Not Move in First Position of Throttle

a. See that the line contactors PI and P2 or P3 and P4 close. If they do not close, look for poor

connections at starting contactor interlocks, throttle control switch, reverser control fingers at reverser and at throttle line contactor operating coil connection. If the contactors do close, but still the locomotive does not move, see that the brakes are released and reverser is set in proper position and that the contacts are in good condition.

b. If none of these remedies the trouble, obtain a voltmeter and check the generator voltage to see that it builds up. If it does not, there is probably an open circuit in the generator shunt field winding.

c. If the battery does not charge, check and replace, if necessary, the fuses in the charging generator circuits.

Section VI. INSPECTION

35. Inspection Routine

a. Inspection work sheets for use in connection with the inspection and maintenance of Department of the Army Diesel Locomotives will be prepared on the appropriate DD Forms 70, 71, 72, 73, and 74.

b. These forms outline procedural steps to be followed in the inspection of the locomotive. They are designed to cover a given period of time and by their use a progressive program of preventive maintenance is accomplished.

c. Correct any defects observed during operation at the inspection period. If it is necessary, make correction at the time of the occurrence.

36. Lubrication

Lubrication as required should be performed during the inspection periods. For a schedule of lubrication, refer to LO 55-1001 (fig. 49) and LO 55-1263 (fig. 50).

37. Inspection Before Leaving Terminal

a. Check radiators for proper height of cooling water.

b. See that lubricating oil in the engine crankcase or in the lubricating oil reservoirs is at the proper height.

c. Start each engine and see that it operates properly. Check the lubricating oil pressure.

d. See that the air compressors operate properly and that the oil level is at the proper height. Also, check the pilot valve or governor adjustment by noting the pressures at which the compressors cut in and out. Readjust if necessary.

e. Examine the radiator fans to see that they function correctly.

f. Operate the air brakes and observe that they function properly.

g. Apply the brakes and open the throttle handle or controller handle slightly for each direction of motion to determine that power is obtained.

h. Check battery charging by noting if the electrical meter in the battery circuit shows CHARGE.

i. Check all auxiliary circuits for blown fuses and lamp circuits for defective lamps.

j. See that the sand boxes are filled and that the sanders operate.

38. Inspection Upon Returning to Terminal

When a locomotive arrives at an inspection terminal at the end of a shift, a complete inspection of the entire locomotive should be made. This preferably should be done as soon as possible after the crew have left the locomotive.

a. Inspect the items mentioned in paragraph 37.

b. Investigate any defects or difficulties reported by the crew and make whatever corrections are necessary.

c. See that all lubrication that depends upon the daily application is properly performed. Certain parts such as pedestal shoes should not be lubricated until just previous to leaving the terminal.

d. Check the brake cylinder piston travel and replace any broken or badly worn brake shoes (recommended piston travel 2" minimum, 4 1/2" maximum. Equal piston travel must be maintained on all brake cylinders).

39. Inspection Every 160 Locomotive Hours or Weekly for 24-Hour Service

In addition to the items covered by shift inspection, the following should be performed:

a. *Locomotive* Journals. Inspect these for proper lubrication and add oil, if necessary, as recommended in the LO 55-1263 (fig. 50). For instructions on packing of the main journals, refer to paragraph 55.

b. Gears. Inspect the traction motor gears to determine if they receive sufficient lubrication. Add lubricant if necessary. For detailed instructions, refer to paragraphs 81 through 94 and LO 55-1263 (fig. 50).

40. **Inspection Every 680 Locomotive Hours or Monthly for 24-Hour Service**

In addition to the items covered by daily and weekly inspections, the following should be performed:

a. Cooling Water System. Drain the entire cooling system, flush to remove sediment, and refill with clean water. If an antifreeze solution is used, it may be replaced after the system has been flushed out and care must be taken to have the proper proportion to prevent freezing.

b. Engine. For engine inspection and maintenance, see TM 55-1001.

c. Generators. Examine the commutator, armature clearance, fields, brushes and brushholders, tension on brushes, and generator leads and bus rings. Blow out with clean, dry air. For detailed instructions, refer to paragraphs 70 through 80.

d. Traction Motors. Examine the commutators, armature clearance, fields, brushes and brushholders, tension on brushes and motor leads. Blow out with clean, dry air. For detailed instructions, refer to paragraphs 81 through 94.

e. Contactors and Relays. Examine for loose connections or worn parts. Examine the tension on the fingers of the interlocks. Inspect the contactor tips and arc chutes and renew any that are badly burned.

(1) *Controllers.* Examine and clean the fingers and inspect the wire connections.

(2) *Switches.* Inspect all hand switches for loose or broken parts. For detailed instructions, refer to paragraphs 95 through 106.

f. Battery. Clean out the battery compartment. Clean the battery and its terminals and apply vaseline to terminals to prevent corrosion. Check height of electrolyte. For detailed instructions on battery, refer to paragraphs 116 through 121.

g. Running Gear. Inspect the running gear for loose bolts, especially on axle caps and gear cases. Inspect the wheels, brake shoes, and brake rigging. Oil the truck centerplates (LO 55-1263, fig. 50).

h. Throttle. Operate the throttle handle and observe that the system works freely without binding and without excessive looseness resulting from wear. See that all bolts in supports and adjustable levers are tight. Place the throttle handle in the full throttle positions and see that the fuel control lever on the diesel engine fuel pump is tight against the full fuel stop. If the locomotive has a hydraulic throttle, lack of sufficient movement may be caused by

(1) The spring in the spring barrel being compressed; if so, extend the throttle rod by hand; or

(2) Air in the lines, in which case the system should be vented. See instructions on venting in paragraph 66.

i. Wiring. See that there are no loose, broken, or high resistance connections in the control wiring circuits. Check the throttle switch for correct setting (see par. 69). Make sure the contacts are in good condition and are making and breaking properly.

41. **Inspection and Overhaul at Periods Greater than Monthly**

a. At least twice a year the fuel oil tanks should be drained and cleaned.

b. At least once a year (or more often if experience proves it necessary) inspect, clean, and repair

(1) Gears and pinions, and other driving parts.

(2) Journal bearings, motor axle bearings, journal boxes, wearing plates on journal boxes, and frame pedestals.

(3) Motor nose suspension.

(4) Wheel treads.

(5) Center plates (if equipped with such). (6) Brake rigging and air brake equipment. (Refer to air brake instruction in TM 55-2021.)

CHAPTER 3
MAINTENANCE

Section I. GENERAL

42. Electrical Equipment

a. Maximum service can be obtained from electric machinery only when it is kept dry and clean. This is especially true when copper dust, brake shoe dust, or other metallic matter may collect in or about the apparatus. All apparatus should be blown out, using dry compressed air, and parts accessible should be wiped off with clean wiping rags. Washed wiping rags are preferable to cotton waste as they are less liable to leave lint. When using air for cleaning in the vicinity of exposed mica insulation, care should be taken not to use too high pressure as small flakes of mica will be blown off, finally resulting in complete destruction of the insulation.

b. Oil is very destructive to insulating materials as it collects dust and dirt causing them to break down electrically. When lubricating apparatus, extreme care should be taken to prevent the lubricant from getting on insulated parts. If any does get on these parts, it should be thoroughly wiped off with clean wiping rags.

c. All screws, bolts, and nuts which secure electrical connections should be kept tight to insure good contact. When making a ground connection, the surface to which connection is to be made should be cleaned thoroughly of all dirt, paint, or rust to assure good electrical contact.

d. Cement may be used to advantage in repairing burned insulation such as arc chutes, sides of contactors, and switches.

e. Use Varnish, Electrical-Insulating conforming to Military Specification MIL-V-1137A for all cables exposed to dirt or moisture, especially where creepage is important. It has high insulating qualities and gives a smooth surface which is easily cleaned.

43. Control Equipment

a. During inspection of control equipment, check for the following:

(1) Loose nuts and screws.

(2) Cotter pins missing or not split.

(3) Broken or weak springs.

(4) Weak contact pressure on interlocks and relay contacts and improper wipe and break.

(5) Grease and dirt on insulating materials.

(6) Worn or burned contactors.

(7) Loose terminals and connections.

(8) Broken insulators.

b. When painting control equipment, use Varnish, Electrical-Insulating conforming to Military Specification MIL-V-1137A.

44. Running Gear and Mechanical

Inspect the trucks and other parts of the running gear equipment as frequently as service conditions may require, for loose or missing bolts and nuts, worn wearing plates, worn or broken bearings, defective gears and gear cases, broken springs, etc. This inspection should include the following parts:

a. Gears and gear cases.

b. Motor axle caps and supporting bolts, nuts, and linings.

c. Motor armature bearings.

d. Motor nose suspension bolts, springs, safety lugs, and hangers.

e. Journal boxes, their wearing plates and bearings.

f. Pedestal wearing plates.

g. Equalizers and springs. h. Dust guards.

i. Thrust plates at end of axles.

j. Wheels.

k. Hub liners.

l. Center plates and side bearings.

m. Brake rigging, including cylinders, levers, hangers, pins, brake shoes, brake shoe heads, and turnbuckles.

n. Sander hose and pipes.

o. Couplers.

p. Motor leads and supporting clamps.

q. Air brake hoses.

45. Engine and Generator Mounting

a. The most common design used in connecting the engine and generator is to bolt the generator frame to the engine. This bolted connection and the connection of the flexible couplings are rabbet fits which give correct alinement of the coupling and a properly equalized air gap.

b. The set is supported by three-point suspension, one on each side of the generator and one at the fan-end of the engine, on a common subbase. Pads are used under the generator supports, the fan-end being rigidly bolted to the support on the subbase. The subbase is fastened to the locomotive platform by bolts.

c. Longitudinal movement of the set is restricted to a total of about 0.016 inch (0.008 in. on each side) by blocks welded to the generator supports. This clearance should be checked occasionally during service to see that it does not become excessive.

d. The engine-generator set subbase is mounted on the locomotive deck-plate on strips of cork laid on the deck-plate under the subbase. The base is held in place by bolts.

46. Water Cooling System

An open circulating system is used to cool each engine. A centrifugal pump circulates the water through the engine cooling water jacket, then through the radiators back to the pump.

a. Filling and Draining Water System.

(1) Before filling the systems, be sure that the drain plugs are tight. Use only clean water and fill through pipes located on the top of the radiators or through the pipes located along the side of the locomotive below the deck plate.

(2) The water supply should be replenished as required to make up the loss from leakage and evaporation.

(3) To drain the water cooling system, open all shutoff valves and remove drain plugs wherever they occur in the water piping. Make certain that all parts of the system, including engine block and any water cooler auxiliaries, are drained.

b. Replacement Water. The water in the system should be drained completely every month. As makeup water is added from time to time, the concentration of the impurities in the water becomes greater. To keep the concentration from getting too strong, the water should be completely changed.

47. Wheel Diameters

Keep the wheel diameter variation within three-eighths of an inch between any two pairs of wheels to avoid too much unbalance in load between the motors. However, it is recommended that the wheel diameters be maintained as nearly equal as railroad shoe practice hermits.

Section II. LUBRICATION

48. Diesel Engine

Refer to TM 55-1001 and LO 55-1001 (fig. 49).

49. Generator

Refer to LO 55-1263 (fig. 50).

50. Motor

Refer to LO 55-1263 (fig. 50).

51. Air Compressor

Keep oil in the crank case at level shown on the bayonet gage which is located in one corner of the crank case. Refer to LO 55-1263 (fig. 50).

52. Control

Refer to LO 55-1263 (fig. 50).

53. Engineer's Brake Valve

The best lubricant for the engineer's valve is a good grade of graphite grease which should be applied very sparingly when the valve is taken apart for cleaning. If necessary, oil may be applied through the oil hole which has a pipe lug in it. However, this should be done only when inconvenient to take the valve apart, and the oil must be applied very sparingly.

54. Brake Cylinder

Refer to TM 55-2021.

55. Main Journals

On locomotives where waste is used in connection with main journal lubrication, pack the journal boxes as frequently as service conditions may require. Use a good grade of wool waste soaked in oil as specified in LO 55-1263 for at least 24 hours and drained for about 6 hours. The temperature of the oil and room in which the waste is drained should be about 60° F. A roll of drained waste (A, fig. 2) should be packed tightly half-way around the journal at the back end and bottom of the box as shown. Packing (B, fig. 2) should be placed in position with moderate pressure against the journal but sufficient to maintain good contact, applying the waste somewhat looser at the sides of the box to prevent wiping effect.

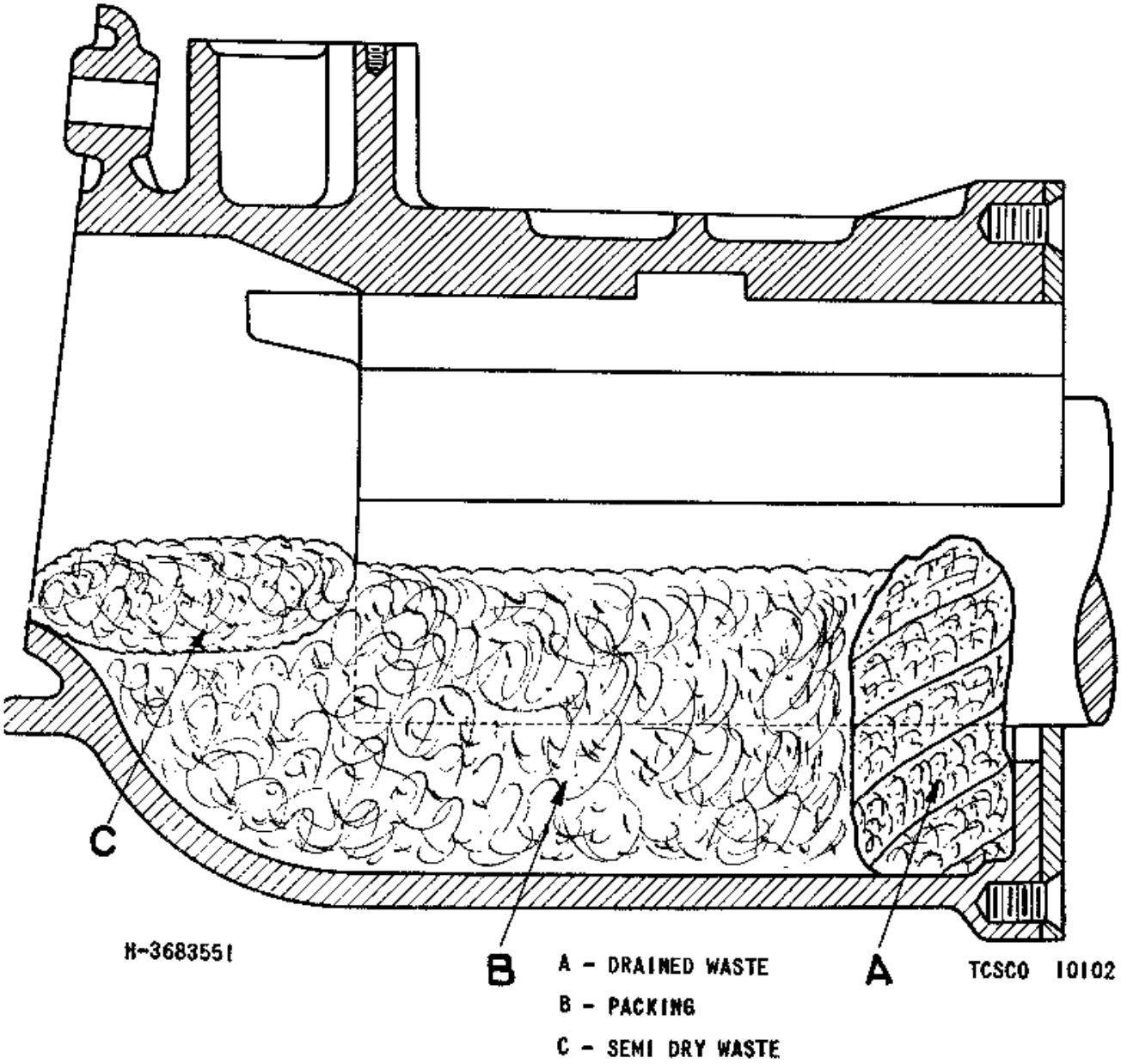


Figure 2. Method of packing journal boxes.

The packing should not extend higher than the center of the journal. After packing is completed, free oil should be poured over the waste along the sides of the box near the center. A wad of semi-dry waste (C, fig. 2) should then be placed between the end of the journal and front end of the box as shown, the purpose of which is to serve as a dirt collector which can easily be renewed as required. (Refer to LO 55-1263 for lubrication instructions.)

56. Traction Motor Gears

a. Single Reduction Gearing. When the locomotive is first put in service, add about 1 pound of grease weekly to each gear case. Make frequent inspection through the filling openings to observe if there is a good film of lubricant on the teeth. The required amount and frequency of adding grease can then be determined. Avoid using more lubricant than necessary, a condition which probably exists when a considerable leakage of grease is noted, and at the same time the gear teeth show a good film of lubricant. (Refer to LO 55-1263 (fig. 50) for lubrication instructions.)

b. Double Reduction Gearing. When the locomotive is equipped with motors using double reduction gearing, all gears and bearings except the bearing on the commutator end of the motor are lubricated from oil in the gear case. (Refer to LO 55---1263 (fig. 50) for lubrication instructions.)

57. Center Plate

Lubricate the center plates at least once a month and oftener if necessary. (Refer to LO 55-1263 (fig. 50) for lubrication instructions.)

Section III. HIGH POTENTIAL TESTS

58. General

Whenever Diesel-Electric locomotives operate under Interstate Commerce Commission regulations they must comply with the requirements given in paragraph number 253 of the Laws, Rules and Instructions for Inspection and Testing of Locomotives other than Steam, governing periodic high potential tests on electric circuits and windings carrying current of potential over 150 volts. While these tests are not required of locomotives in purely industrial service, it is mandatory that they be performed on all Department of the Army Diesel Locomotives on an annual basis and after general overhaul or extensive repairs to the electrical apparatus.

59. Preparing For Tests

To prepare the locomotives for these tests, proceed as follows (refer to fig. 48)

a. Clean the electrical circuits and windings to be tested by blowing out with dry compressed air. *b.* Lift all of the generator brushes so that they will clear the commutator and disconnect the following:

(1) Cables between reversers and GA connection on generators.

(2) Cables between reversers and ammeter shunts.

(3) Connections from GA to GS on both generators.

(4) Ground wires on field shunting control relays VI and V2I.

c. Block main contactors P1, *P2, P3,* and PI_E closed.

d. Set the reverser for either forward or reverse direction.

e. See that the engine starting contactors *GS1* and *GS21* and generator field contactor *GF1* are open. Also see that the throttle is in idle position.

f. Do not disconnect generator ground cable GKK.

g. In order to avoid excessively high potential surges, always connect the high potential test wires to the circuits before energizing the test wires.

h. To avoid any possibility of personal injury, always stay outside of and at least 10 feet from the locomotive while tests are being applied.

60. Application of Test Voltage

a. The normal operating voltage of the traction motor and generator is considered as 225 volts. This is 75 percent of the approximate generator voltage at the maximum permissible speed of the locomotive.

b. The normal operating voltage of the battery and low voltage control circuits is considered as 37.5 volts. This is 2.34 volts per cell of battery, which is the approximate normal charging current.

c. To apply high potential tests to each of the main circuit and motor windings, connect one high potential cable

cable to any convenient point on the circuit to be tested and the other to the frame of the locomotive, and apply the test voltage specified by ICC requirements.

d. To test the generator armature, place one high potential lead on the generator commutator and the other on the locomotive frame and apply the test voltage specified by ICC requirements.

e. The generator commutating field windings, the starting field winding as well as the low voltage generator leads, always operate at less than 150 volts and are therefore not included in the high potential circuit.

f. Although the ICC requires the application of only 50 percent above normal voltage to windings, it is permissible on this equipment to apply a high potential test value of 75 percent above normal working voltage except to the windings connected on the low side of the generator armature.

g. After tests have been completed, remove all testing connections, restore all wiring and connections, and remove blocking from contactors.

Section IV. POWER PLANT AND LOCOMOTIVE THROTTLE CONTROL TESTS AND ADJUSTMENTS

61. Description of Power Plant

The locomotive contains two power plants, each consisting of a diesel engine direct-connected to a traction generator. The engine generator set furnishes power to drive the traction motor or motors which are geared to the wheels.

62. Power Plant Operation

a. The maximum utilization of the locomotive power plant is obtained over a wide range of operating conditions by properly coordinating the diesel engine power output and the traction generator excitation. This depends on the proper adjustment of the diesel engine fuel supply and the external field resistors of the traction generator.

b. When the locomotive is operated at full throttle, the power output of each power plant is in accordance with the generator characteristic curve (fig. 3) and is limited by the setting of the full fuel stop screw on the diesel engine fuel pump. However, at partial throttle positions, the power plant output, and therefore the locomotive performance, is determined by the locomotive throttle control system which provides varying degrees of generator excitation, together with the proper fuel setting at any position of the throttle handle and at the same time establishes the necessary electrical circuits for application of power to the traction motor or motors. At all partial throttle positions, it is important that, within limits, the individual power plants divide the total load equally.

c. In preparation for and while making tests, the following points should be kept in mind at all times in order to safeguard equipment and personnel

(1) Carefully observe all instructions pertaining to the operation of the locomotive power plants.

(2) Make all test wiring connections tight and insure that they are well insulated. Any wires temporarily disconnected while making tests should be insulated and isolated so they cannot become grounded, or contact rotating equipment, control devices, or terminals.

63. Hydraulic Throttle

a. A clean hydraulic system will work better and last longer. Take every precaution to prevent dirt and abrasives from entering the system.

b. Never handle any internal part of a hydraulic system with dirty, greasy hands. Even a trace of oil or grease will contaminate the brake fluid and cause rubber parts to deteriorate and swell.

c. If welding is done near either cylinder, the cylinder must be protected or removed. The rubber parts will not stand temperatures above 180° F.

d. Never operate the system with the fluid reservoir less than half full.

e. Always use the best grade of hydraulic brake fluid. Inferior fluids will clog the lines and damage the rubber parts.

f. Be sure that the clamping bolts holding the operating arms on the serrated shafts of both the master and slave cylinders are tight. Any slippage here will strip the serrations and ruin the arm and/or the shaft.

g. At all times while making adjustments, the

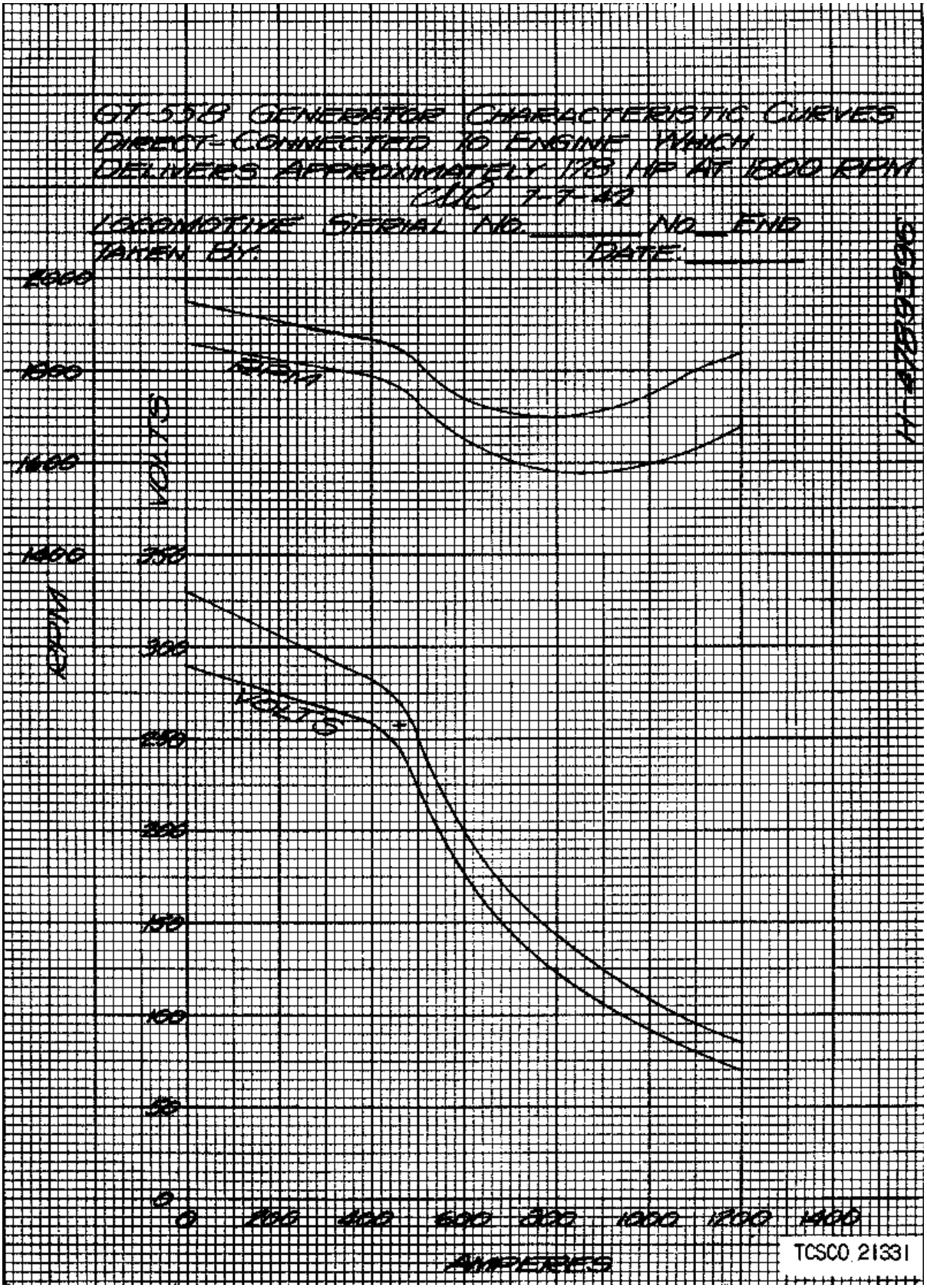


Figure 3. Characteristic curve scale, Generator GT-558.

roller follower must clear the idling cam when the throttle handle is returned to the idling position.

h. The entire hydraulic system must be tight and free of leaks before attempting to make any adjustments.

i. When making adjustments of even a temporary nature, be sure that all lockwashers are in place and that all locknuts are drawn up tight.

64. Air In Hydraulic System

The presence of air in the hydraulic system will result in generally unsatisfactory operation. This may be detected by holding the external throttle linkage at the slave cylinder firmly by hand while the throttle handle is brought up to the full throttle position. If the slave cylinder movement is not firm and positive especially in the later part of its stroke (near full throttle), the system contains air or leaks at some point. Spongy or non-positive movement in the early part of the stroke is not serious and may be ignored. To eliminate air, follow the procedure outlined in paragraph 66.

65. Leaks In Hydraulic System

a. To locate leaks, wipe all joints in the piping between the master and slave cylinders clean and dry, then operate the throttle handle several times and carefully inspect each point for brake fluid. Repair any leaks before proceeding.

b. Leaks at pipe threads may be corrected by disassembling the joint, cleaning the threads, and applying a mixture of 7 parts of litharge with 3 parts of glycerin (by volume) to the full length of the threads, being very careful not to allow any of the mixture to enter the hydraulic system, then reassembling the joint. Allow it to dry for at least 1 hour before applying pressure. Mix only a small amount sufficient for immediate needs, since the cement will quickly dry out and become useless. Keep the litharge tightly covered when not in use. A joint made with this cement may be loosened only by heating.

c. Internal leaks in the system may occur at the rubber piston cups in either the master or slave cylinder or at the needle valve in the master cylinder piston. This needle valve is provided to compensate for losses or expansion of fluid in the hydraulic system and is open only when the throttle system is in the idle position. Any dirt on the needle valve or its seat will prevent it from closing when the throttle handle is advanced, thereby allowing fluid to flow through the piston instead of moving the slave cylinder piston. To correct this, disassemble the master cylinder and clean all parts thoroughly.

Caution: Use only alcohol, isopropynol, or clean brake fluid for cleaning. Never use kerosene, gasoline, or any petroleum derivative.

d. Take every precaution to keep all parts clean while disassembled, and reassemble the parts in exactly the same order and relative positions as they were found originally. Wash in brake fluid just before reassembly to provide initial lubrication.

e. Leaky piston cups may be corrected only by replacing the cups. These do not ordinarily give trouble unless they have been in contact with oil, grease, gasoline, or kerosene and therefore should not be replaced until all other possibilities are exhausted.

66. Venting the Hydraulic System

If the system contains air as a result of loss of brake fluid due to evaporation, leaks, or neglect to keep the reservoir filled, it must be vented. Provide equipment and proceed as outlined below:

a. Equipment Necessary.

(1) A reworked filler cap for the brake fluid reservoir, having a hose connection and with the two small vent holes plugged.

(2) Two clean cans of 1-gallon capacity. One can must have a hose connection at the bottom.

(3) A bleeder hose with a fitting suitable for attachment in the slave cylinder vent plug.

(4) A 7-foot length of rubber hose.

(5) One gallon of a good grade hydraulic brake fluid.

b. Procedure.

(1) Fill the reservoir with brake fluid and install the reworked filler cap. Also remove the breather from the slave cylinder crank-. case and add brake fluid until the crankcase is about two-thirds full.

(2) Use the rubber tubing to join the reworked filler cap and the 1-gallon can with the hose connection at the bottom. Fill the can with brake fluid and set it on the operator's cab roof or elevate it to some position approximately equal to cab roof height. Remove the dust cap screw in the slave cylinder and install the bleeder hose

with the other end inserted in the second 1-gallon can.

(3) Open the vent plug about 2 turns and allow approximately one-half gallon of the brake fluid to flow through the system. Stroke the master cylinder operating arm at intervals during this time, always returning it to the off end of its travel. Then close the vent plug and repeat the same operation on the other end of the locomotive.

(4) After venting both ends, remove the test equipment and restore original reservoir filler cap and slave cylinder dust cap screws.

67. Idling Adjustment

a. It is important that the engines idle at speeds that are high enough to allow the auxiliary generators to charge the batteries. For proper operation of the throttle system, it is also necessary that both the master and slave cylinders are at the extreme retracted or off end of their travel. In this position, both cylinders should be firm against internal stops. Be sure that the master cylinder operating arm clears the idling cam by at least one-thirty-second inch when the throttle handle is in the idle notch and the master cylinder is back against its internal stop (fig. 4).

b. Start with the ball stud H (fig. 5) set approximately in the center of the slotted adjustment. Then adjust the length of the throttle rod at G to obtain the following idling speeds for 65-ton locomotives

Locomotive	*Idling Speed, r.p.m.*	
	Compressor Unloaded (Set to)	*Compressor Loaded (Minimum)*
65-ton	590± 10	550

c. The idling speeds should be within the above limits, the minimum being with the compressor loaded and pumping against full main reservoir pressure, and the maximum with the compressor unloaded.

68. Generator Characteristics

a. The generator characteristics are checked and adjusted in order to maintain good locomotive performance at full throttle operation. Tests should be made when a decrease in locomotive output is evident. Observe the following procedure:

(1) Install test meters and equipment in accordance with figure 7 and provide a tachometer to read engine speed. The tachometer shaft rising vertically from the distributor assembly on the diesel engine fuel pump is a convenient place to apply the tachometer and is exposed by removing the dust cap. This shaft rotates at one-half engine speed.

(2) Take a full load curve for each generator, using a water box as load. For each curve, record generator voltage, load current, speed, and sufficient field voltage and current to indicate field resistance during test. (3) Before proceeding, see that the fuel control lever on the diesel engine fuel pump is tight against the full stop when the throttle handle is in the full throttle position. If not, advance the full throttle cam (fig. 4) and recheck until it is tight. b. Insert test resistors as shown on figure 7 in the self and separately excited field circuits to provide equivalent resistances to those encountered in service with a warm generator. Adjust the resistors to obtain the following values:

Self excited field, ohms.	5.9
Separately excited field, ohms.	6.3

c. If no resistors are available, operate the power plant at full throttle with approximately 375 amperes load until the above field resistors are obtained (fig. 48).

d. Keep the compressor unloaded during generator tests.

e. Set the external field resistors R11-1112 and 1121-1122 at approximately 25 ohms.

f. After setting the external field resistors, take a full load curve beginning at 1200 amperes and decreasing to 0 amperes by approximately 200-ampere steps. Compare this with the generator characteristic curve (fig. 3).

Caution: Do not hold currents above 1000 amperes for more than 3 minutes at a time. Take all readings with a decreasing load.

g. The generator characteristic may be varied over a considerable range by adjusting the external field resistors 1111-1112, R21-1122, R15-1116, or 1125-1126. The resistors R15-1116 and R25-1126 affect the high current, low voltage portion of the characteristic curve most and should be adjusted first, after which the low current, high voltage section of the curve may be regulated by adjusting resistors 1111-1112 or 1121-1122. In general, decreasing the resistance of these resistors will cause the voltage to rise and the speed to fall until a limit is reached, after which further decrease in the resistance will result in both lower voltage and lower speed. If the resistance is increased, just the opposite will occur and eventually the curve will begin to assume an incorrect shape (fig. 48).

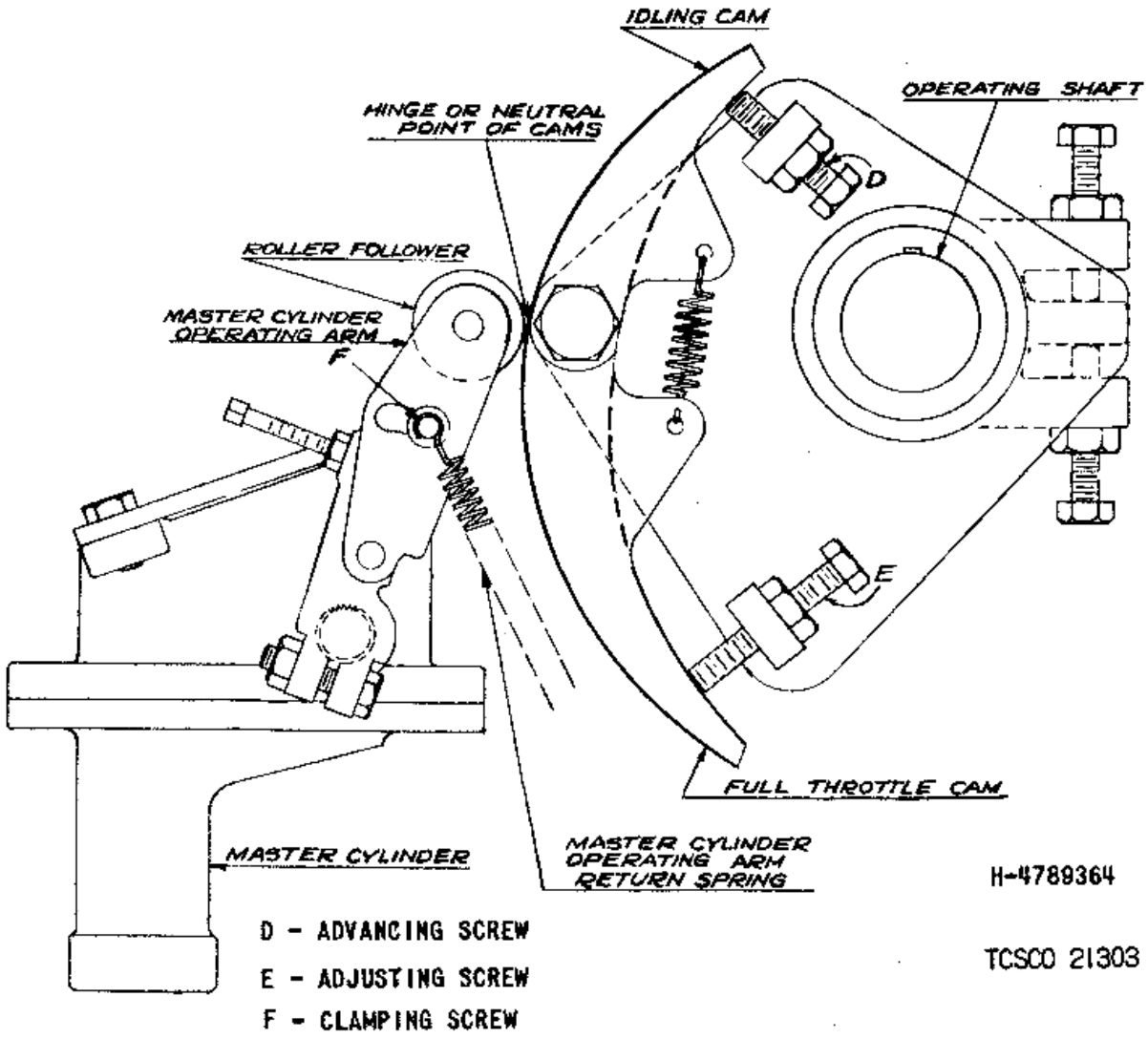


Figure 4. Master cylinder and cam arrangement used in hydraulic throttle control.

h. The shape of the voltage characteristic is dependent on stalling the engine speed somewhat, but for best operation the engine speed should not be less than 1500 rpm at any point.

i. Adjust the external field resistor until the best possible characteristic is obtained. If this is too low to be satisfactory (usually 10% low in voltage between 600 and 300 amperes is the lowest acceptable limit), inspect the engine carefully; low power may also be due to normal fuel pump wear which can be compensated for by backing out the full fuel stop screw slightly. If the screw is backed out too far, the engine exhaust will become excessively smoky, a condition that should be avoided.

j. If any corrections are made to the engine, recheck the characteristics, readjust the external field resistors, and repeat until a suitable curve is obtained.

k. If adjustment of the full fuel stop screw is no

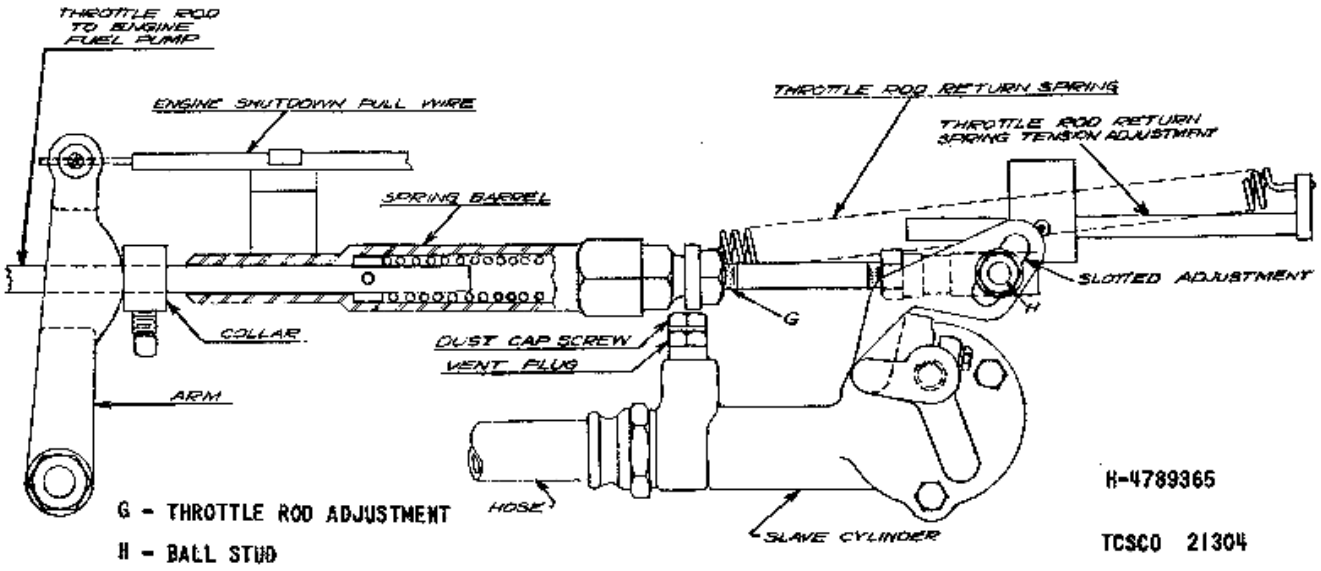


Figure 5. Slave cylinder and throttle rod arrangements used in hydraulic throttle control.

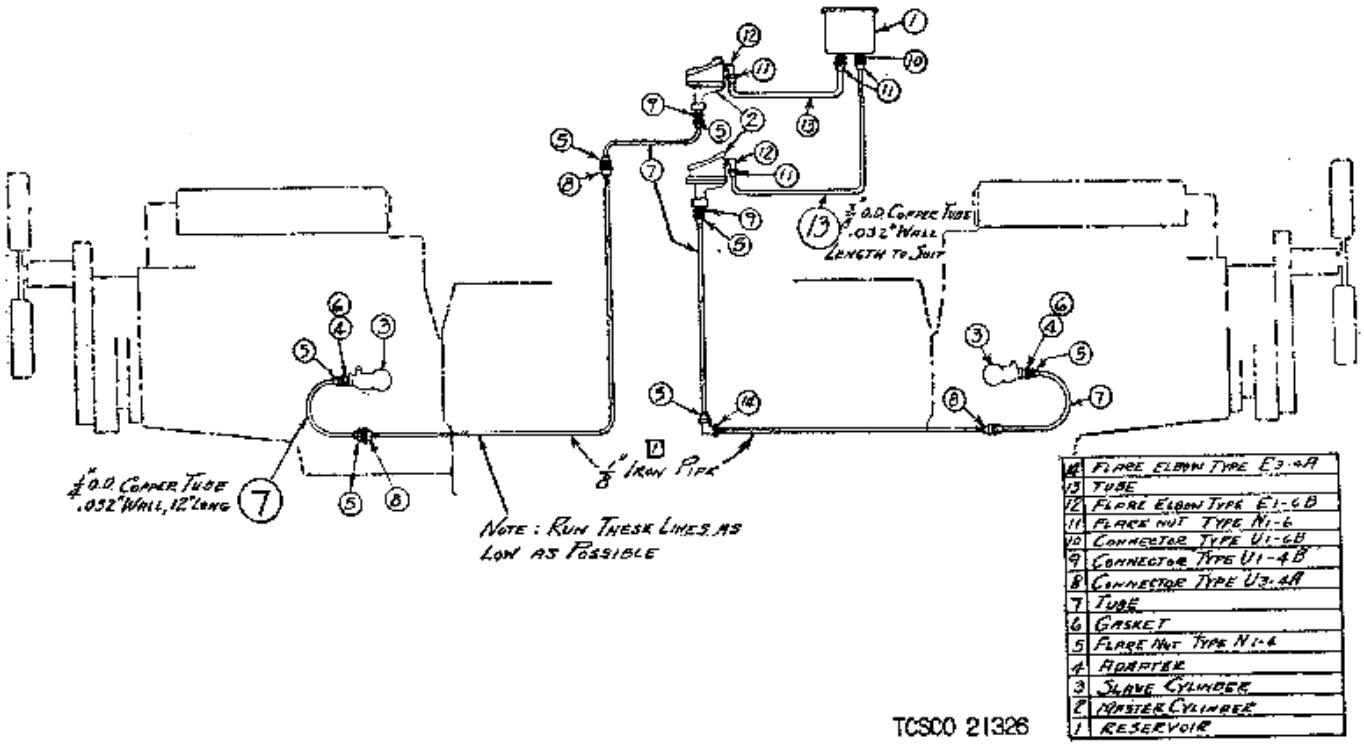

3/8" O.D. COPPER TUBE .032" WALL LENGTH TO SUIT
1/4" O.D. COPPER TUBE .032" WALL, 12" LONG
3/8" IRON PIPE
NOTE: RUN THESE LINES AS LOW AS POSSIBLE
16 FLARE ELBOW TYPE E3-4A
15 TUBE
12 FLARE ELBOW TYPE E1-6B
11 FLARE NUT TYPE N1-6
10 CONNECTOR TYPE U1-6B
9 CONNECTOR TYPE U1-4B
8 CONNECTOR TYPE U3-4A
7 TUBE
6 GASKET
5 FLARE NUT TYPE N1-4
4 ADAPTER
3 SLAVE CYLINDER
2 MASTER CYLINDER
1 RESERVOIR
TCSCO 21326

Figure 6. Hydraulic throttle fluid piping diagram.

longer effective, the fuel pump or engine or both should be reconditioned.

l. The full fuel stop screw is set and sealed at the factory to give the proper power output. The seal should not be broken or the screw adjusted until all other possibilities are exhausted. If it becomes necessary to make adjustments with this screw, it is recommended that it be resealed after adjusting to prevent indiscriminate movement. In any case, it should be adjusted only at the time a water box test is made to check generator characteristics.

69. Power Plant Tests at Partial Throttle (For Cummins HBIS-600 Engines with Fuel Pumps-Serial Number 24684 and Above)

a. Throttle control system adjustments at partial throttle positions are made primarily to equalize the load distribution between the two power plants. Load unbalance may be detected by comparing the load indicator or ammeter readings for the power plants simultaneously and at steady load (if load indicators or ammeters are not provided, connect a meter in each generator circuit for the purpose of checking the load distribution). When color band scale load indicators are used, the variation between the meters should not be more than the width of the yellow band. If graduated scale ammeters are used, the readings should agree within 50 amperes if the meters read single motor current or 100 amperes if the meters read current through two motors in parallel.

b. Load unbalance may be encountered when the throttle handle is between the line contactor pickup and the first running position, which is only about one-half inch of throttle handle travel along the quadrant. This will not cause any damage and should be ignored since no appreciable load can be pulled by the locomotive when the throttle handle is in this range.

c. Since the engines have two-speed governors, do not attempt to make or check any adjustments at partial throttle positions based on no-load speed or voltage. The engine speed and generator voltage are dependent on the load, and the engine governor exercises no control at partial throttle points except to prevent the engine from overspeeding when load is removed.

d. If the load unbalance exceeds the permissible limits, adjust the throttle control system. This will not only correct the condition but will also coordinate the diesel engine power output and the generator excitation to give proper locomotive acceleration. Observe the following procedure:

(1) Check the operation of the throttle control switch (TC) with the following table and adjust if necessary. The dimensions indicated are the distance in inches for the respective position measured along

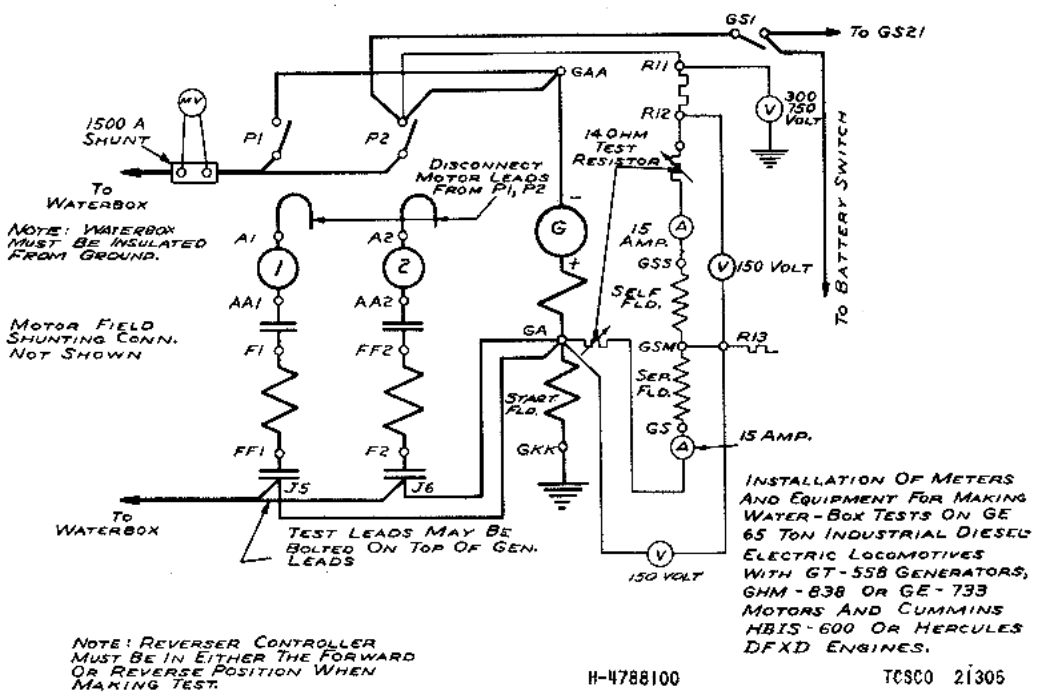


Figure 7. Installation of equipment for water box tests.

the inside edge of the quadrant from the idle position of the throttle handle.

Motor Line Contactors Close (P1, P2, P3, P4)	1 5/16
First Running Position (all fingers of throttle control switch closed	1 ¾ ± ½
First Step of Separate Excitation Resistance Added (R14-R16, R24-R26)	4 ½ ± ½
Second Step of Separate Excitation Resistance Added (R15-R16, R25-1126)	5 3/8 ± ¼

(2) Install a test shunt and millivoltmeter in each main generator-motor circuit to read generator output. If test meters are not available, the panel load indicator shunt with a suitable millivoltmeter or even the load indicators themselves may be used for a rough check of generator current.

Note. Each load indicator reads current in only one motor which is one-half the generator output. The load indicator scales change color from green to yellow 325 amps and yellow to read 375 amps.

Connect an 0-300/750 volt voltmeter (using the 0-300 volt scale) between R11 and ground as shown on figure 7. This will read generator voltage. Do not operate the locomotive at full throttle with this meter connected, since the generator voltage may be higher than 300, resulting in possible damage to the meter. Provide a tachometer to read engine speed. The tachometer connection rising vertically from the distributor assembly on the diesel engine fuel pump is a convenient place to apply the tachometer and is exposed by removing the dust cap. This shaft rotates at one-half engine speed.

(3) With the engines shut down, place the throttle handle at the point where the first step of separate excitation resistance has been added ($4^1/1$-in. $\pm\ 1/4$-in. up the quadrant), then rotate the operating cams by means of adjusting screws A until the roller follower falls on the hinge or neutral point between the two halves of the cam as shown on figure 5.

(4) Make sure the engines are in operating condition, then start the one that is to be checked first, set the brakes so the locomotive cannot move, bring the throttle handle up to the first running position (all throttle switch fingers must be closed), and check the generator load and speed.

Caution: Do not hold this load for more than $^1/_2$ minute at a time. Allow the locomotive to move a few feet between each trial.

(5) The generator load at this point should be 600 amps., 18+3 volts at 510+25 rpm. engine speed. If the engine speed is high at the first running position, reduce the idling speed 5 to 10 rpm and recheck. If the load is high, increase the resistance of generator field resistor R13-1114 or R23-R24. If speed or voltage is low, follow the reverse procedure.

(6) The first running position load may be checked either by loading the generator on the stalled traction motors as described above or by loading it on a water box in which case connections may be made as shown on figure 7. This adjustment will have effect on lower throttle handle positions (up to the point where the first step of separate excitation resistance is added).

(7) Partial throttle adjustments at the point where the first step of separate excitation resistance is added and higher should be made with the locomotive connected to a water box. The load setting corresponds to the current and voltage that would be obtained if the generator was loaded on stalled motors; however, the load is somewhat too high to be held on stationary motors for a long enough time to be able to obtain a satisfactory reading and, in addition, the brakes could not hold the locomotive at standstill.

(8) If the traction generator is connected to a water box, make adjustments as described below:

(a) Bring the throttle handle up to the point where the first step of separate excitation resistance has been added and check the generator load and speed. These should be 880 amps, 27±5 volts at 800 ±50 rpm.

(b) If speed and load are low, increase the engine fuel setting by advancing the master cylinder jointed operating arm (fig. 4). Increasing the resistance of generator field resistor R14-R15 by moving the sliding band R15 only, will also help to correct this condition. This permits the engine speed to rise, which in turn will increase the generator voltage for the given current (880 amps.). If speed and load are high, follow the reverse procedure.

(9) DO NOT ATTEMPT TO MAKE ANY ADJUSTMENTS WHILE HOLDING THIS LOAD. Return the throttle handle to the idle position, make any changes that may be required, then recheck the load.

(10) After obtaining a satisfactory setting, return the throttle handle to the idle position and advance the idle cam to within onethirty-second inch of touching the roller follower. Make this adjustment by advancing screw D (fig. 4). THE ROLLER FOLLOWER MUST CLEAR THE CAM WHEN THE THROTTLE HANDLE IS IN THE IDLE POSITION.

(11) With the engine running without load, place the throttle handle in the full throttle position and see that the fuel control lever on the diesel engine fuel pump comes up against the full fuel stop. The spring in the spring barrel (fig. 5) should be compressed one-sixteenth to one-eighth inch under these conditions. If not, advance or retract, as required, the full throttle section of the operating cams by means of adjusting screw E (fig. 4) until the desired results are obtained. If adjustments to .equalize the load distribution are made without the benefit of a water box, the above procedure should be observed except it is desirable to operate both power plants together for comparison between the two, since accurate load and speed adjustments are not practical.

e. After completing adjustments for each end of the locomotive, check the entire throttle system to be sure all locking devices are tight and that all lockwashers are in place, particularly clamping screw F (fig. 4).

f. Place the throttle handle in the full throttle position, see that the fuel control lever on the diesel engine fuel pump is against the full fuel stop screw, then locate the collar on the throttle rod to clear the engine shutdown operating arm by approximately one-sixteenth inch (fig. 5). Do this with the operating arm at its extreme forward position (toward the fan end of the engine), then tighten the set screw clamping the engine shutdown pull wire in the arm. Start the engines and see that they will shut down from idling speed when the engine shutdown knob in the operator's cab is pulled.

Section V. TRACTION GENERATOR

70. Description

This generator is designed especially for traction purposes. Its armature is flexibly connected to an internal combustion engine. The generator rotates in a counter-clockwise direction, looking at its commutator end. It has a single exciting field winding, self and separately excited from the battery, giving correctly proportioned excitation at various loads, so as to match engine output curves at all throttle positions.

71. Ventilation

The generator is cooled by air drawn into the machine by a fan. It is therefore essential that sufficient amount of cool, clean air be provided, and provision made to prevent re-circulation of the exhaust air. Adequate ventilation will not be obtained unless the fan discharges against pressure no greater than intake air pressure.

72. Inspection

Apparatus should be inspected often enough to prevent failures in service. This should include the examination of the following items

a. Cleaning.

b. Commutator.

c. Brushes.

d. Brushholders.

e. Lubrication.

f. Field coils and connections.

73. Cleaning

a. It is essential that this apparatus be kept clean at all times. The machine should be blown out with dry compressed air at least once a month. Approximately every 6 months the insulation on the commutator cap should be cleaned and, when dry, painted with varnish, Electrical-Insulating conforming to Military Specification MIL-V-1137A. The brushholder support insulator should be wiped clean. Any accumulations of oil and dirt should be removed.

b. After cleaning, examine the condition of insulation varnish. If cracked, flaked, or blistered, the parts should be treated with varnish as described in maintenance instructions.

74. Disassembly of Generator (fig. 8)

a. To remove the generator from the engine, first remove the engine generator set from the locomotive, then place fiber or pressboard shims into the air gap of the generator so that the armature will not drop down on the pole pieces when disconnected. Disconnect all cables from the set. Remove the 10 bolts (23) from the engine side of the flywheel, joining flywheel to coupling, working through opening in bell housing, one bolt at a time. With the engine blocked up and a hoist on the generator, remove the 16 bolts (21). The generator should then be drawn forward so that the coupling clears the engine, after which it may be hoisted up. Care should be exercised to keep loosened parts blocked up to prevent upsetting or falling.

b. To remove armature from frame, first lift brushes and wrap heavy paper around commutator surface to protect it. Remove pulley from shaft extension, using a suitable puller. Disassemble cap screw (29), lockwasher (28), and endplate (27). Remove the six inner cap screws (7). By using two jack screws in the two tapped holes in the end plate (10), it is possible to push the bearing housing assembly out of its fit in the magnet frame. The armature may then be removed through the engine end of the frame. Care should be exercised in the handling of parts so as not to damage them, particularly the windings and commutator.

c. To remove generator bearing, first remove key from shaft, and pull off sleeve (6), using suitable puller (fig. 11). Unscrew the two flat head machine screws holding (5) to (2) and remove bearing cap (5). Remove outer flinger (3) using suitable puller (fig. 11). With studs engaging the tapped holes from which bolts (7) were removed, it is possible to remove bearing (4) complete with inner bearing cap (2) and inner flinger (3) from the shaft.

75. Care and Maintenance

a. Field Coils.

(1) When field coils are to be removed, provision should be made to keep each pole, coil, and accompanying shims together.

(2) To remove a field coil, disconnect the cables, remove the bolts which hold the pole to the frame, and remove pole and coil through the end of the frame. The main field coils can readily be slipped off of the pole. The commutating coils are built integral with the pole and should be handled as a unit.

(3) The condition of the insulating varnish surface on the field coils should be examined and, when necessary, the following treatment should be given.

(4) Paint or preferably heat coils to 110° C., (230° F.,) and dip while hot in varnish, Electrical-Insulating conforming to MILV-1137A and drain thoroughly. Bake for 8 hours at 120° C., (248° F.).

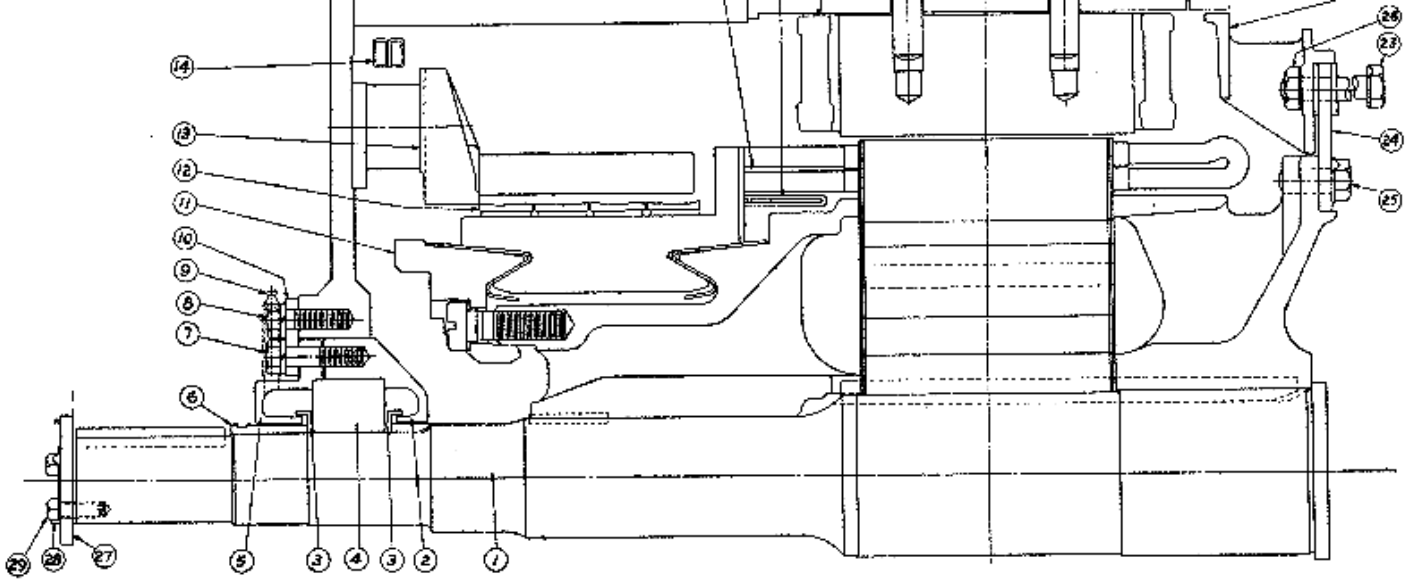
(5) Before reassembling, the terminals and contact surfaces of the poles should be clean. When assembling main field coils, new coils or coils that have been hot dipped should be assembled in the frame while hot. The hot coils will have more give to them to allow pulling down the poles tight against the frame. Poles and accompanying shims should be placed in their original positions.

(6) Whenever pole piece bolts are removed, new lockwashers should be provided upon assembling.

(7) After coils are reassembled, care should be taken that the cables are properly connected. Connections must be tight. Re
fer to generator connection diagram (fig. 10), and carefully check coil polarity.

b. Brushes and Brushholders.

(1) A periodic inspection of brushes and brush holders should be made, and the following points should be observed.



29 CAP SCREW
28 LOCKWASHER
27 END PLATE
26 NUT
25 CAPSCREW FOR COUPLING
24 COUPLING DISC
23 CAP SCREW FOR FLYWHEEL & COUPLING
22 FAN
21 CAPSCREW-THRU ENGINE BELL HOUSING
20 MA6NET FRAME
19 POLE PIECE BOLTS
18 FIELD COILS
l7 EQUALIZERS
16 ARMATURE COIL
15 COVER
14 BRUSH HOLDER BUS RINGS
13 BRUSH HOLDER SUPPORT
12 BRUSH HOLDER
11 COMMUTATOR
10 ENO PLATE
9 GREASE FITTINGS
8 CAP SCREW
7 CAP SCREW
6 BEARING SLEEVE
5 BEARING CAP-OUTER
4 BEARING
3 FLINGER
2 BEARING CAP-INNER
1 SHAFT

Figure 8. Longitudinal section, Generator GT-558

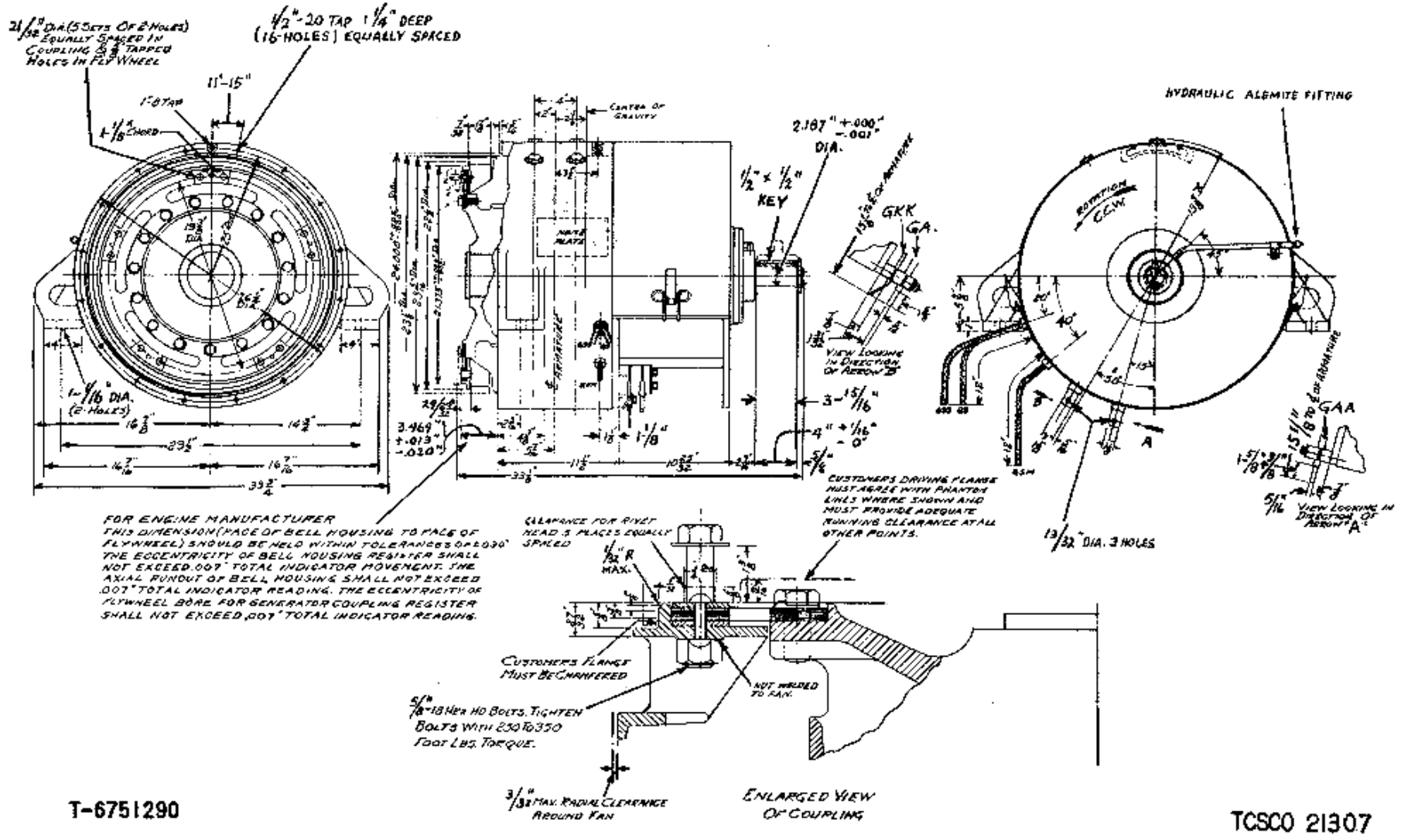
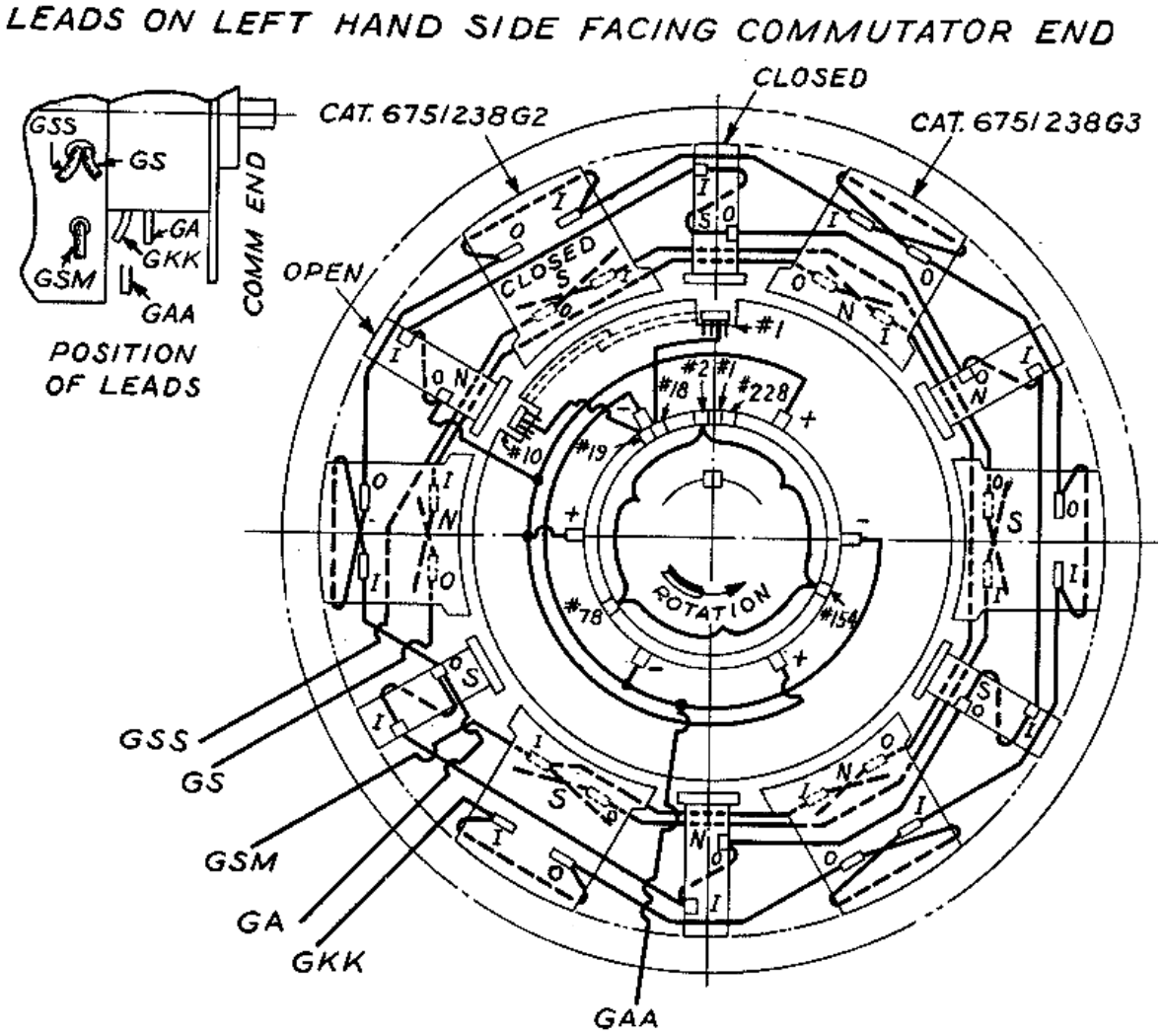

21/32" DIA. (5 SETS OF 2 HOLES) EQUALLY SPACED IN COUPLING TO 3/4" TAPPED HOLES IN FLYWHEEL
1/2"-20 TAP 1 1/4" DEEP (16 HOLES) EQUALLY SPACED
11°-15"
1"-8 TAP
1 1/8" CHORD
1-9/16" DIA. (2 HOLES)
2.187" +.000" -.001" DIA.
1/2" x 1/2" KEY
GKK
GA
3-15/16"
4" +1/16" -0"
3.469" +.013" -.020"
HYDRAULIC ALEMITE FITTING
ROTATION CCW
GAA
13/32" DIA. 3 HOLES
VIEW LOOKING IN DIRECTION OF ARROW A
VIEW LOOKING IN DIRECTION OF ARROW B
CENTER OF GRAVITY
NOTE PLATE
FOR ENGINE MANUFACTURER THIS DIMENSION (FACE OF BELL HOUSING TO FACE OF FLYWHEEL) SHOULD BE HELD WITHIN TOLERANCES OF ±.030" THE ECCENTRICITY OF BELL HOUSING REGISTER SHALL NOT EXCEED .007" TOTAL INDICATOR MOVEMENT. THE AXIAL RUNOUT OF BELL HOUSING SHALL NOT EXCEED .007" TOTAL INDICATOR READING. THE ECCENTRICITY OF FLYWHEEL BORE FOR GENERATOR COUPLING REGISTER SHALL NOT EXCEED .007" TOTAL INDICATOR READING.
CUSTOMER'S DRIVING FLANGE MUST AGREE WITH PHANTOM LINES WHERE SHOWN AND MUST PROVIDE ADEQUATE RUNNING CLEARANCE AT ALL OTHER POINTS.
CLEARANCE FOR RIVET HEAD 3 PLACES EQUALLY SPACED
1/32" R MAX.
CUSTOMER'S FLANGE MUST BE CHAMFERED
NOT WELDED TO FAN
5/8"-18 HEX HD BOLTS. TIGHTEN BOLTS WITH 250 TO 350 FOOT LBS. TORQUE.
3/32" MAX. RADIAL CLEARANCE AROUND FAN
ENLARGED VIEW OF COUPLING
T-6751290
TCSCO 21307

Figure 9. Outline, Generator GT-558.



GEN.	TURNS	ARMATURE COIL	EXCITING FIELD	COMMUTATING FIELD
6T-558 C-/	1	CAT4748375GI	CAT. 675123862(CLOSED)	CAT. 47464I9GI(OPEN)
		EQUALIZER CAT. 6738219G1	CAT 675123863(CLOSE)	CAT 4746442GI(CLOSED)

Figure 10. Connection diagram, Generator GT 558.

(2) Brushes should move freely in the holders, and not be stuck with dirt or other foreign substance. Raise and lower the brushes in the carbonways so as to release any dirt that may have accumulated. Care should be taken not to snap the spring, as this may chip the brush.

(3) Replace brushes that have been chipped or worn excessively, with the same grade of brush or equal. Especially is this true when only a partial replacement is made, as two widely different kinds of brushes on the same machine may be detrimental to its successful operation. When new brushes are put in, they should be fitted to the commutator by sandpapering. If only a few brushes are to be fitted, a piece of sandpaper is inserted under the brush and drawn in the direction of rotation; lift the brush when moving the paper back, and keep the paper close to the commutator to avoid rounding the edges of the brush.

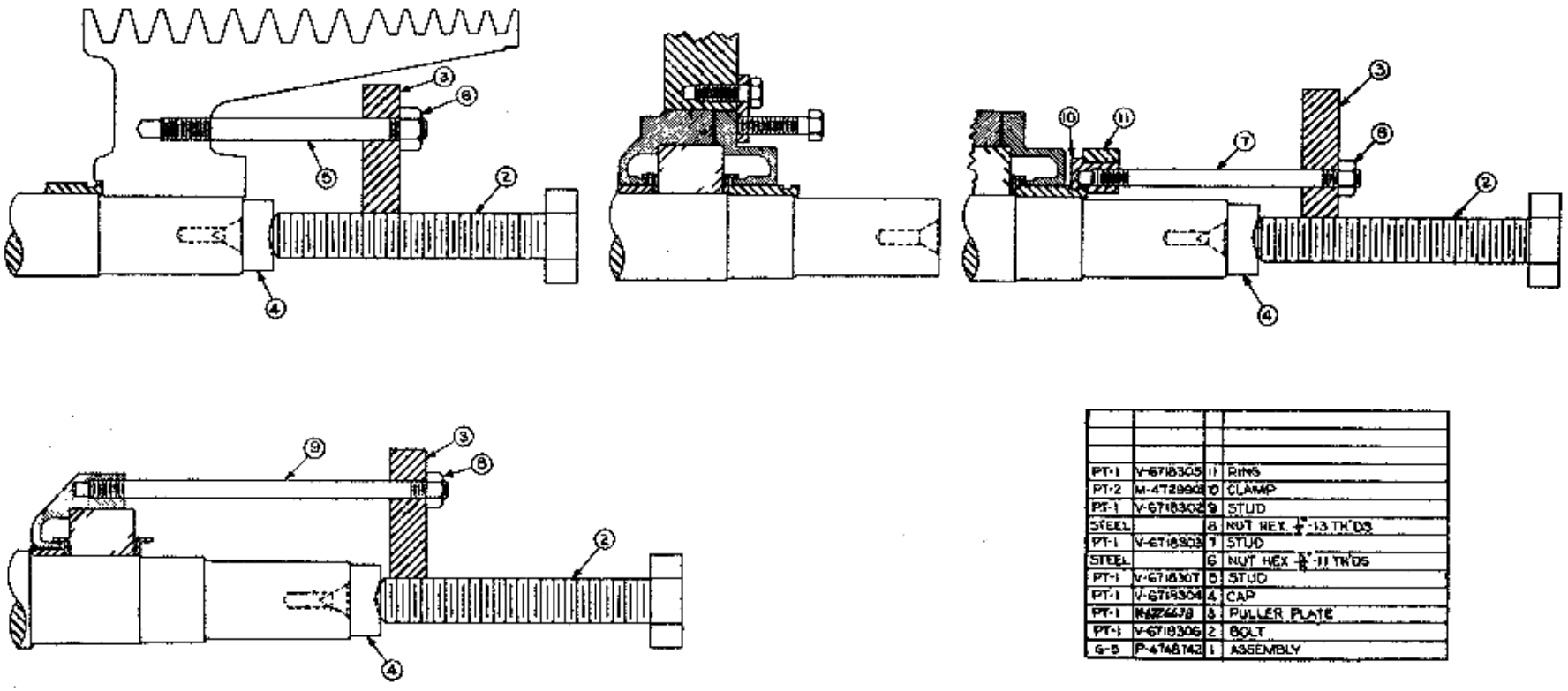

PT-1 V-6718305 11 RING
PT-2 M-4728908 10 CLAMP
PT-1 V-6718302 9 STUD
STEEL 8 NUT HEX. 1/4"-13 TH'DS
PT-1 V-6718303 7 STUD
STEEL 6 NUT HEX 5/16"-11 TH'DS
PT-1 V-6718307 5 STUD
PT-1 V-6718304 4 CAP
PT-1 M4726478 3 PULLER PLATE
PT-1 V-6718306 2 BOLT
G-5 P-4748742 1 ASSEMBLY

Figure 11. Puller for Generator GT-558.

(4) When a complete set of brushes is to be fitted, and where conditions permit, wrap a piece of sandpaper around the commutator and rotate the armature in the proper direction, the sandpaper being held in place so that it rotates with the commutator. Refer to figure 12 for method of sanding.

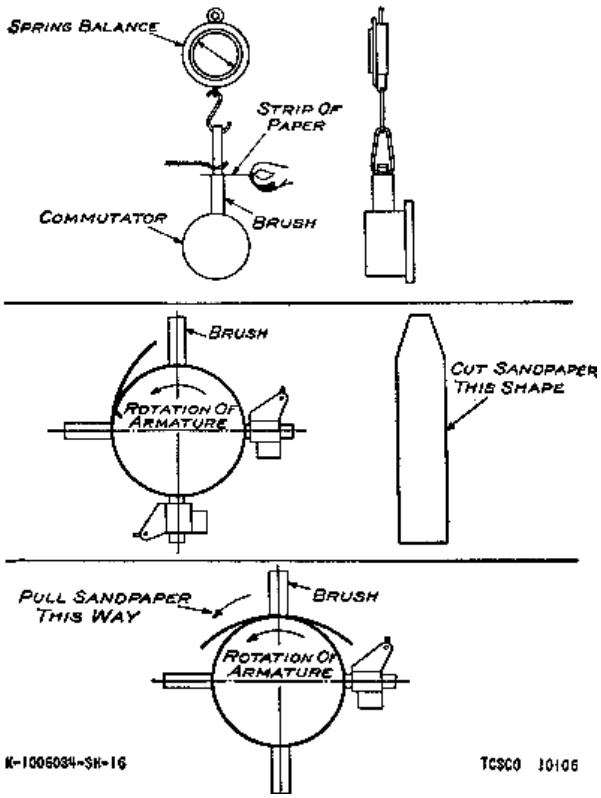


Figure 12. Method of sanding and obtaining brush pressure.

(5) Proper brush pressure should be maintained, as specified in paragraph *80d.* It is important that all brushes be adjusted to the same pressure, as unequal brush pressure will cause unequal current distribution in the brushes. Refer to figure 12 for method of measuring the brush pressure.

(6) Maintain 1/8-inch clearance between the bottom of brushholder and the commutator. The support is arranged in such a way that the brushholder studs may be moved toward the commutator surface as the commutator wears or is turned, so as to maintain the 1/8-inch clearance between the face of brushholders and commutator. Brushholders should be kept rigidly bolted in place.

(7) The pigtails on the carbon brushes should be arranged so as to clear the commutator riser on the armature and the window in the body for the finger.

c. Commutator.

(1) The commutator should present a polished surface free of pitting. If it becomes pitted from arcing at the brushes, it should be cleaned with fine sandpaper (not carborundum or emery) or stoned. When stoning the commutator, extreme care should be taken to keep the copper dust from the windings by using a cardboard shield or some other means; the fan outlets on the main generator must be covered to keep it from sucking the dust into the machine. After stoning or sanding, the machine should be carefully blown out with dry compressed air.

(2) If the commutator is badly worn or burned, the armature should be placed in a lathe and the commutator turned enough to give a uniform surface. Before turning the commutator, a suitable head covering should be placed over the end windings to prevent the chips from working into the armature. While turning, the peripheral speed of the commutator surface should be about 300 feet per minute. Round off the ends of the commutator segments to at least 1/16-inch radius with a file.

(3) After the commutator has been turned, the side mica should be grooved to the depth shown in paragraph 80f. For the side mica thickness, refer to paragraph *80f.* Special saws are available for this purpose. Do not cut the slots too wide. The sharp edges of the bars should be removed with a hand scraper or knife. Do not bevel the segments. Remove all mica fins and inspect to see that no copper chips remain. Final polishing with a fine grade of sandpaper is recommended.

(4) Do not apply lubricant to the commutator as it is detrimental to operation. If the commutator is not kept clean and free of grease and oil, carbon dust will collect in the grooves between the segments and will tend to cause a short-circuit.

d. Armature.

(1) The armature should be closely inspected for the condition of bands, coils, insulation, general assembly, and the commutator.

(2) The armature bands should be tight and secure. Soldering on the bands should be intact. If solder has thrown off, the cause should be determined and corrected and bands replaced.

(3) The coil insulation should be clean and free of blisters, flakes, or cracked insulating varnish surface. When the condition of the insulating varnish on the armature is such that treatment is necessary, heat the armature to 100° C., (212° F.) and dip hot in insulating varnish specific gravity 1.15 to 1.18 at 30° C. Thoroughly drain excess accumulation of varnish and bake for 24 hours at an oven temperature of 120° to 125° C. (248° to 257° F.).

e. Balance. The armature is dynamically balanced at the factory. If anything is done to the armature which will in any way disturb this balance, it should be rebalanced dynamically for best performance.

f. Lubrication.

(1) The generator roller bearing is grease lubricated.

(2) The grease fitting should be examined regularly to see that it is not damaged so as to allow dirt to enter the bearing. Before greasing, the fitting should be wiped clean so as not to force dirt into the bearing with the grease.

(3) The amount of lubrication depends largely on the service requirements. Grease should be added periodically but not excessively as it will work out of the housing and be thrown off to the detriment of the unit when it gets on brushes, commutator, and windings, and clogs ventilating passages.

(4) As conditions dictate, bearing assemblies should be taken apart and thoroughly cleaned with kerosene or similar solvent for the purpose of removing the accumulation of old and hardened grease from bearing, housings, and grease passages.

(5) The self alining spherical bearing of the main generator should be carefully examined, turning the inner race with rollers and cage at right angles. The outer race should be similarly examined. If in the opinion of the examiner the bearing condition is questionable, a new bearing should be installed and steps taken to have the questionable bearing reconditioned or scrapped.

(6) Immediately after bearings have been cleaned in the solvent, they should be further washed in a light mineral lubricating oil of SAE-10 grade. This is to prevent corrosion of the highly polished surfaces.

(7) When the bearing compartment is clean and dry, repack with fresh grease. When reassembling, pack bearing compartment two-thirds full.

(8) It is recommended that a regular greasing schedule should be established after experimenting to determine the frequency and the amount of lubricant required for the particular service that this equipment is to perform (LO 55-1263, fig. 50).

(9) In general, experience has shown that the main generator bearing needs only approximately 1 ounce of grease added at infrequent intervals.

76. Reassembly

In general, reassembly procedure is the reverse of the disassembly procedure outlined above. Care should be taken in assembling bearing parts to prevent scoring the engaging surfaces of tight fitting parts.

77. Testing After Repairs

Generators that have been repaired after running in service must not be given over one-half the voltage specified for the high potential test for a new machine. For main generator armature, commutating field, and starting field, use not over 1200 volts; for main generator shunt field, use not over 550 volts.

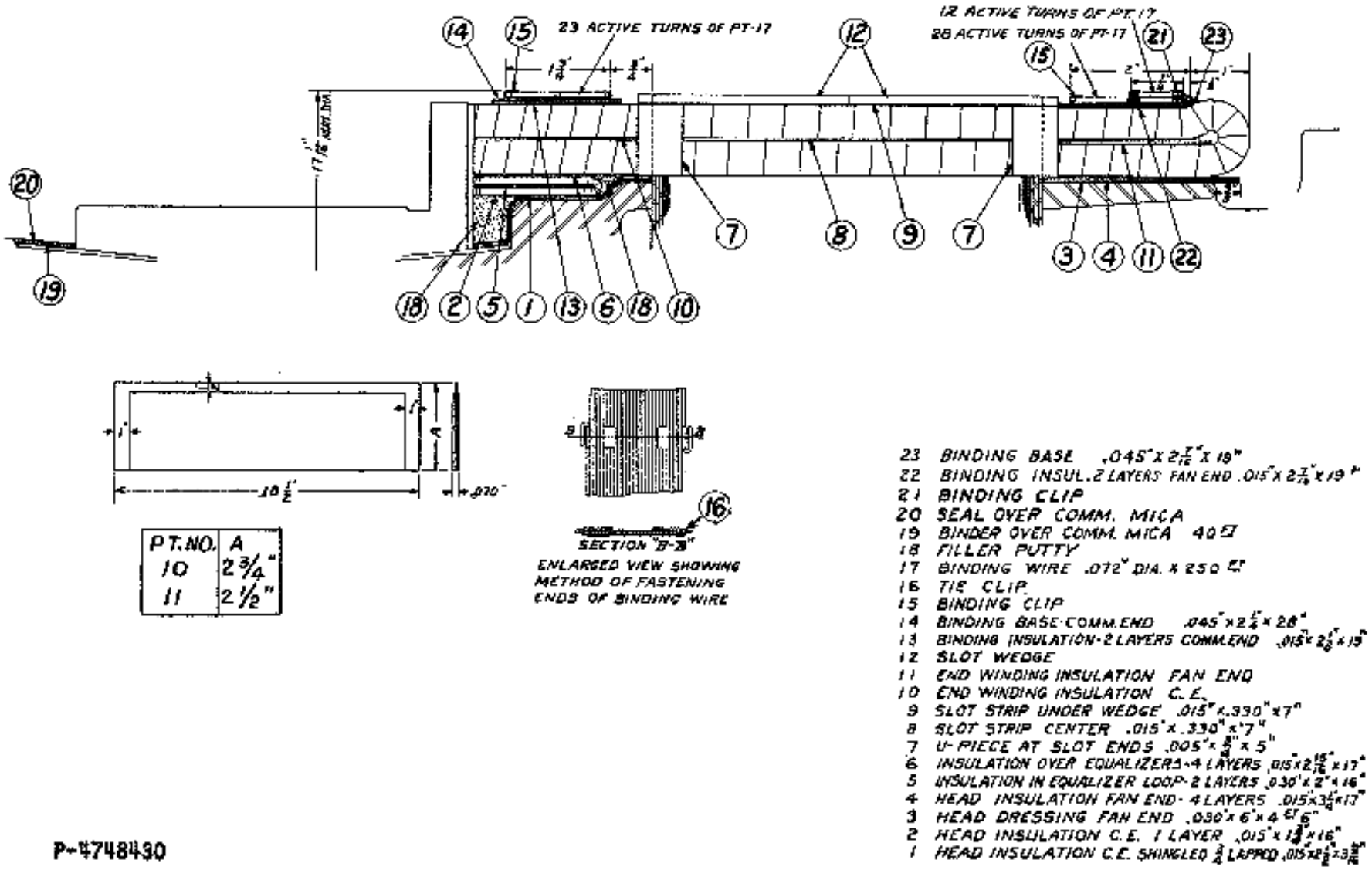

23 ACTIVE TURNS OF PT-17
12 ACTIVE TURNS OF PT-17
28 ACTIVE TURNS OF PT-17
PT. NO. A
10 2 3/4"
11 2 1/2"
SECTION "B-B"
ENLARGED VIEW SHOWING METHOD OF FASTENING ENDS OF BINDING WIRE
23 BINDING BASE .045" X 2 7/16" X 19"
22 BINDING INSUL. 2 LAYERS FAN END .015" X 2 7/16" X 19"
21 BINDING CLIP
20 SEAL OVER COMM. MICA
19 BINDER OVER COMM. MICA 40 CT
18 FILLER PUTTY
17 BINDING WIRE .072" DIA. X 250 CT
16 TIE CLIP
15 BINDING CLIP
14 BINDING BASE COMM. END .045" X 2 1/4" X 28"
13 BINDING INSULATION - 2 LAYERS COMM. END .015" X 2 1/8" X 19"
12 SLOT WEDGE
11 END WINDING INSULATION FAN END
10 END WINDING INSULATION C. E.
9 SLOT STRIP UNDER WEDGE .015" X .330" X 7"
8 SLOT STRIP CENTER .015" X .330" X 7"
7 U-PIECE AT SLOT ENDS .005" X 3/4" X 5"
6 INSULATION OVER EQUALIZERS - 4 LAYERS .015" X 2 15/16" X 17"
5 INSULATION IN EQUALIZER LOOP - 2 LAYERS .030" X 2" X 16"
4 HEAD INSULATION FAN END - 4 LAYERS .015" X 3 1/4" X 17"
3 HEAD DRESSING FAN END .030" X 6" X 4 CT 6"
2 HEAD INSULATION C.E. 1 LAYER .015" X 1 3/4" X 16"
1 HEAD INSULATION C.E. SHINGLED 3/4 LAPPED .015" X 2 1/2" X 3 29/32"
P-4748430

Figure 13. Armature insulation, Generator GT-558.

78. Inspection After Repairs

After repairs have been made, a careful check should be made that no foreign matter remains in the machines, and that there are no loose brushes or other obstructions on the commutator. Check the connections with the connection diagram (fig. 10) and see that all bolts are drawn up tightly and locked.

79. Locating Trouble

a. Armature Heating. Armature heating may result from any of the following causes:

(1) Overloading or inadequate ventilation.

(2) A partial short-circuit of two coils, heating the two coils affected.

(3) Short circuits or grounds in the armature winding or commutator.

(4) Bad commutation, with consequent large circulating currents in the armature coils undergoing commutation.

(5) General heating of the armature may be caused by

(a) Unequal air gap.

(b) Reversed field coil.

(c) Short-circuited or grounded field coil.

b. Field Coils. Overheating of field coils may result from the following causes:

(1) Partial short-circuit of one or more coils.

(2) Faulty insulation or improper connections.

(3) Check the connections of the field coils with the generator connections diagram (fig. 10). Check for reversed field coil by exciting the fields from some source (battery, etc.), and holding two iron rods against the adjacent pole tips all the way around; the free ends of the rods should attract each other. A faulty coil may be detected by exciting the fields from some source and taking the voltage drop across each coil separately; a variation of over 10 percent in the drop indicates faulty coil.

(4) It should be noted that the main generator has more than one winding on each pole, and care should be taken to see that correct terminals are used; consult the cable connections drawing.

c. Commutator Heating. Excessive temperature on the commutator is generally caused by the following:

(1) Heavy overload for prolonged period.

(2) Sparking at the brushes.

(3) Improper brush pressure.

(4) Poor condition of the commutator. A blackened or rough surface increases the brush friction and the contact drop, both of which cause increased temperature.

d. Contact Heating. Bolted contacts may heat if the contact surfaces are not clean, smooth, and bolted together with sufficient pressure. See that the contacts of connecting strips are tight.

e. Poor Commutation. Sparking at the brushes may be due to any one of the following causes:

(1) Excessive overload.

(2) Brushes may not be fitted to the surface of the commutator.

(3) Brushes may not have proper pressure, or the pressure may not be the same on all brushes.

(4) Brushes may bind in the holders.

(5) Brushes may have reached their limit of wear.

(6) Brushes may be burned on the ends.

(7) The commutator may be dirty, oily, rough, or worn out.

(8) A commutator bar may be loose or may project above the others.

(9) High mica.

(10) Grounded or short-circuited armature coils.

(11) Loose connection between armature lead and commutator bar.

(12) Flat spot on the commutator.

(13) Commutator out of true.

(14) Armature badly out of balance.

80. Maintenance Data, Type GT-558-J1 Generator

a. Classification: 6 pole d-c, commutating pole type, generator.

b. Nominal Rating for Traction Purposes: Input -165 hp at 1800 rpm.

c. Resistances at 25° C.

(1) Shunt field ---------- 10.20 ohms
(2) Commutating field ___. 0.00321 ohm
(3) Starting field --------- 0.0218 ohm

d. Brush Data.

(1)	Pressure	52 to 62-oz per brush
(2)	Size	5/8-in by 1 ¼-in, by 1 15/16-in long
(12)	Grade	GE-377

e. Average Air Gap.

(1)	Exciting	0.0772 in.
(2)	Commutating	0.126 in.

f. Commutator Side Mica.

(1)	Groove Depth	3/64 in.
(2)	Thickness	0.050 in.

g. Bearing Grease Capacity

(2/3 Full) ---------- 9 oz

h. Weight of Entire Unit (With Coupling) 1830 lb

Section VI. TRACTION MOTOR TYPE GHM-838-D1-250 VOLT MOTOR

81. General

The GHM-838-D1 motor is a four-pole, direct current commutating pole motor, designed for operation either fully inclosed or with forced ventilation. The frame is of the box type. The armature is carried on roller bearings in separate frameheads, bolted to the frame. Motor suspension bearings are of the split sleeve type, lubricated by oil in waste packed axle caps. Single reduction gearing is inclosed in split type gear cover. There are two brushholders accessible through the commutator covers. For connections, resistances, brush pressures, wearing limits, etc., refer to paragraph 94.

82. Lubrication

a. Armature Bearings.

(1) For lubrication of armature bearings, refer to LO 55-1263 (fig. 50).

(2) When lubricant is to be added to the bearings, the *exclusion o f dirt* from the bearinghousing and the lubricant is *very important.*

(3) The amount of grease and the frequency at which it should be added depend largely on the severity and character of service, hours of operation per day, and operating temperatures of motor and bearings.

b. Commutator-End Bearing. After 6 months of operation, remove the commutator-end end covers, using every precaution to prevent dirt from entering into the bearing chamber. If the end cover is found to contain an excessive amount of grease (more than 60 percent of available space), overlubrication is indicated. Over-lubrication is also indicated by grease throwing at the edge of commutator cap. If the end cover contains only a very small amount of grease, under-lubrication is indicated. Before reassembling end cover, clean out all old grease and fill with fresh grease to not more than 60 percent of available space.

c. Pinion-End Bearing. It is obviously not practicable to remove the end cover for the purpose of checking the greasing schedule. The quantity of grease found to be correct for the commutator end bearing should be adequate also for the pinion-end bearing. Over-lubrication of the pinion-end bearing is indicated by grease throwing; the armature flange may be inspected after removing one of the vent hole covers on frame or frame head.

d. Axle Bearings.

(1) The lubrication of these bearings depends on capillary attraction for feeding the oil from the reservoir to the journal surface of the axle. Long-fiber, all-wool yarn is the most desirable bearing packing. The individual pieces of yarn should be at least 12 inches long.

(2) To insure initial lubrication of the bearings after packing, the packing previously should be thoroughly saturated with the oil. Unless special provision is made for saturating the packing, it should be soaked in the oil for at least 48 hours and drained for about 24 hours, at about 16° C., (60° F.).

(3) Since the oil will climb up straight strands of the packing yarn faster than it will pass through a number of balls or wads of the packing, it is desirable that the packing be in the form of a wick in the housing and the larger the wick the easier it will be for necessary oil to reach the journal.

(4) The pieces of packing required for the wicks for the axle bearing should be made into skein forms of sufficient length to reach from the bottom of the waste chamber up to about 6 inches above seat for the wastechamber cover. The skeins should then be

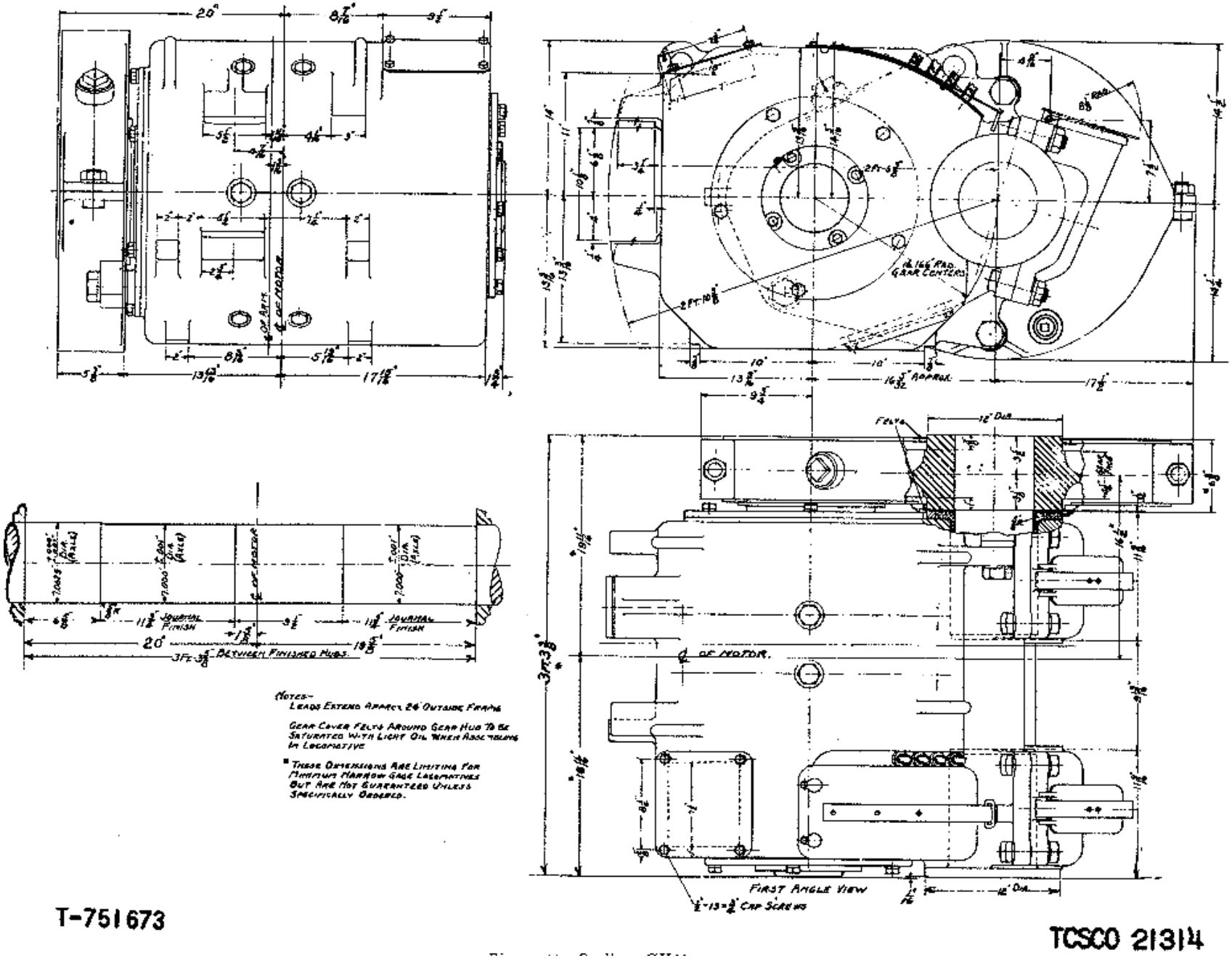

T-751673
TCSCO 21314
FIRST ANGLE VIEW
Notes—
Leads Extend Approx 24" Outside Frame
Gear Cover Felts Around Gear Hub To Be Saturated With Light Oil When Assembling In Locomotive
These Dimensions Are Limiting For Minimum Narrow Gage Locomotives But Are Not Guaranteed Unless Specifically Ordered.

Figure 14. Outline, GHM motor.

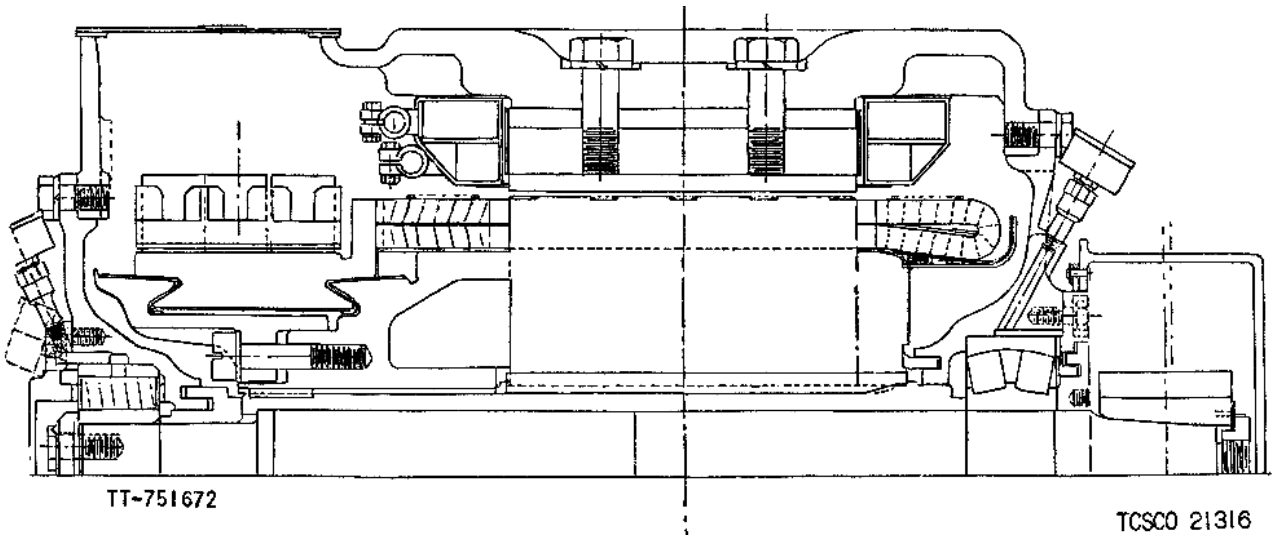


Figure 15. Longitudinal section, GHM motor.

twisted about one complete turn in order to hold all of the strands of yarn in place and produce a more springy wick and as many skeins as possible packed in the waste chamber, starting at the inner end of the bearing and working outward, and allowing the upper ends of the skeins to hang out over the seat of the cover about 6 inches or enough to hold them in place.

(5) After the wick is formed in the chamber, it should be pressed over horizontally, tight against the axle, by means of a suitable packing iron and held in place by forcing the necessary additional packing behind it. The loose upper ends of the skeins of the wick should then be folded over the other waste and tamped down tight.

(6) A pad of the saturated waste, large enough to fill the remainder of the waste chamber, should be placed on top of the wick to catch and hold the dirt which might fall in when the axle cap cover is opened.

(7) The oil is poured into the filing chamber of the axle cap provided for this purpose. The depth of oil may be gauged by means of a stick or ruler placed in this chamber. Oil should be supplied to a depth corresponding to an oil level which is one-eighth inch higher than the lowest point of the axle journal. This depth should not be exceeded in order to prevent the oil running out through the bearings. (Refer to LO 55-1263 (fig. 50) for lubrication instructions.)

e. Gearing. The gear lubricant should be heavy enough to maintain a protective film on the teeth even under heavy loads (refer to LO 55-1263).

83. Inspection (Once a Month)

a. Countersinks for the pole-piece bolts on the top of the frame are filled with compound to prevent water leaking into the motor. If the compound is broken, the pole bolts should be tightened, the holes cleaned, and new compound poured in.

b. Check for tightness of the axle cap bolts to prevent wear of axle caps resulting in spread of the gear center distance, and consequent failure of the gearing.

c. Check the lubrication according in the instructions given in paragraph **82**. Check the bearing wear in accordance with paragraph 94.

d. Inspect the brushholders for cracked insulators, chipped or worn brushes, and tightness of terminals and shunts. For the brush pressure, see paragraph 94.

e. Note the general internal cleanliness of the motor; clean out with dry cloth or blow out with compressor air. Note appearance of the commutator. If an excessive amount of grease or oil is found inside the motor, steps should be taken to correct this condition.

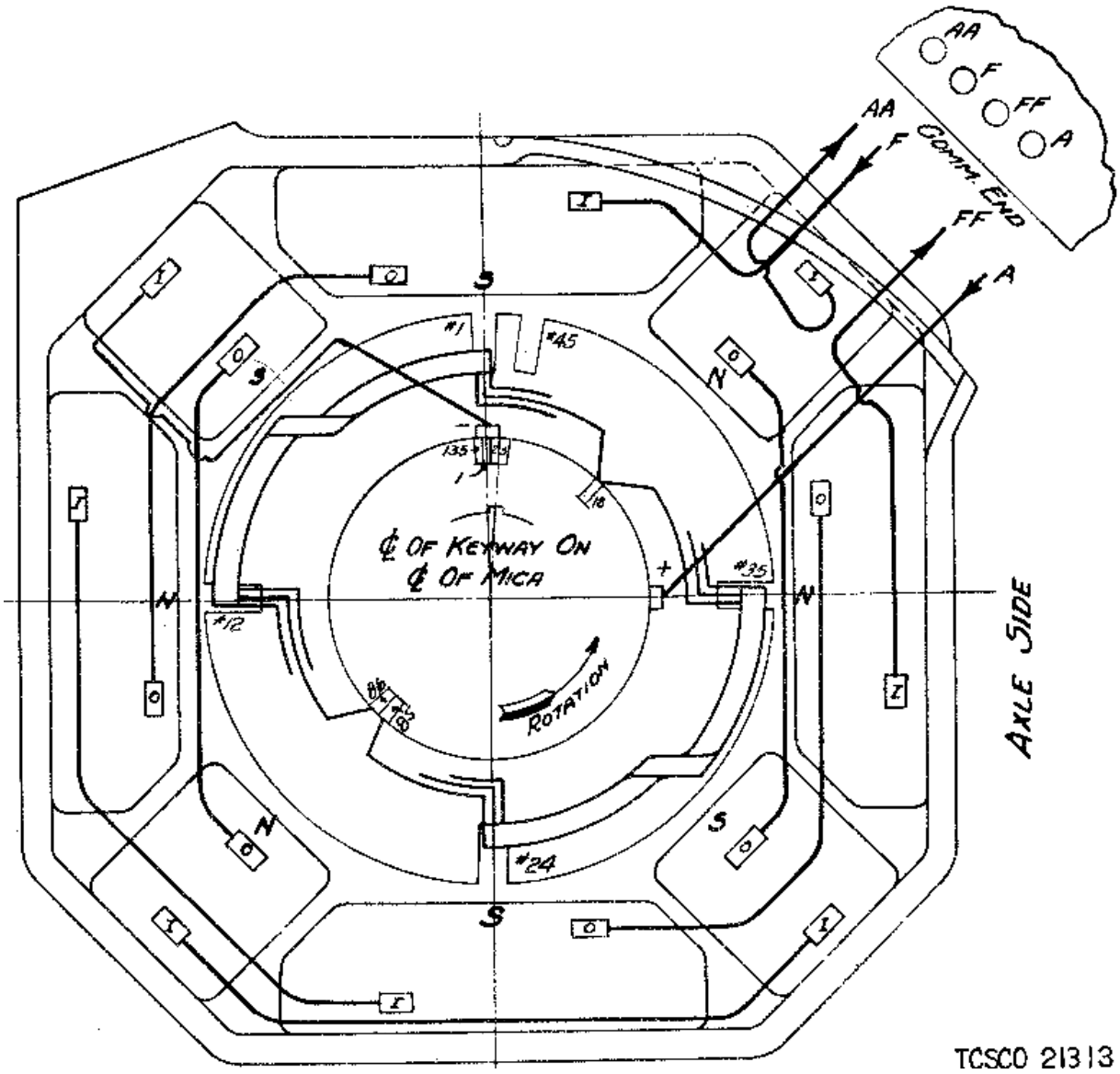


Figure 16. Connection diagram, GHM motor.

f. Check for tightness of the connections. Cables should be securely tied.

84. Repacking Bearings

a. At intervals of from 1 to 2 years (depending on service conditions), the bearings should be removed entirely for cleaning and inspection. Remove the old grease, clean the bearings, and grease chambers thoroughly with kerosene or other petroleum cleaner and repack with grease. This is important, for if grease runs too long without renewal, it will lose most of its lubricating qualities.

b. At about 10,000 miles, or usually every 4 to 6 months, the axle bearings should be repacked with new waste.

85. Gear Covers

When the motors are overhauled, clean the gear covers thoroughly. Do not burn the grease out as the cover will warp out of shape and allow dirt to enter.

86. Brushholders, Brushes, and Commutator

a. The brushes should never be allowed to wear so short that there is danger of the lever striking the bottom of the slot in the carbonway. Spring pressure should be maintained to the value given in paragraph 94. This pressure should be sufficient to give good contact with the commutator without causing excessive friction. To obtain a good contact surface, use a fine grade of sandpaper. Place the rough side of the sandpaper next to the brush and pull through slowly with the brush under ordinary pressure. Wipe off the commutator after fitting the brushes, or blow out with compressed air. Keep the brushholder insulators clean but do not sand them.

b. The commutator should present a polished surface free of pitting. The mica between the copper segments is initially grooved to a depth of threesixty-fourths inch. With wear of the commutator, maintain this groove. High mica will spoil the brush fit and cause sparking. If the commutator becomes blackened or pitted from arcing at the brushes, it should be cleaned with fine sandpaper or a commutator stone, and blown out with compressed air. Care should be taken that this process does not leave the commutator out of round. If the commutator is excessively worn or burned, the armature should be placed in a lathe and the copper turned down just enough to give a uniform surface, after which the mica must be grooved. In doing this, protect the windings from flying copper chips.

c. Commutator slotting machines and special saws are available for grooving the mica. Do not cut the slots too wide. After grooving, carefully scrape out the slots and inspect them to see that no copper chips remain. It is important also to round off the ends of the commutator bars to one-sixteenth inch radius and to break sharp edges of bars. Do not apply lubricant to a commutator as the brushes are so composed as to be self-lubricating. Oil collected on the commutator will carbonize, becoming conductive, and when lodged in the grooves will aggravate a short circuit between bars. Maintain a clearance of one-eighth to one-fourth inch between the bottom edge of the carbonway and the commutator surface and keep brushholders rigidly bolted in position.

87. Pinion Removal

For removal of the pinion, refer to figure 17.

88. Pinion Assembly

a. Thoroughly clean the taper of the shaft and the bore of the pinion, using carbon tetrachloride to remove every trace of oil or grease.

b. Inspect shaft for upset metal at end of taper and other nicks, which should be corrected to obtain a perfect fit.

c. Inspect bore of pinion for any possible damage. The pinion should have at least 80 percent perfect fit on shaft.

d. Mount the cold pinion by placing it on the shaft and snapping it in position by hand. Measure the cold position of the pinion on shaft, using a micrometer depth gage. Mark at circumference of pinion the two places where depth gage was resting; this may add to the accuracy when determining the final pinion advance in mils.

e. Remove pinion from shaft and mark it so that the same pinion finally will be mounted on the same shaft.

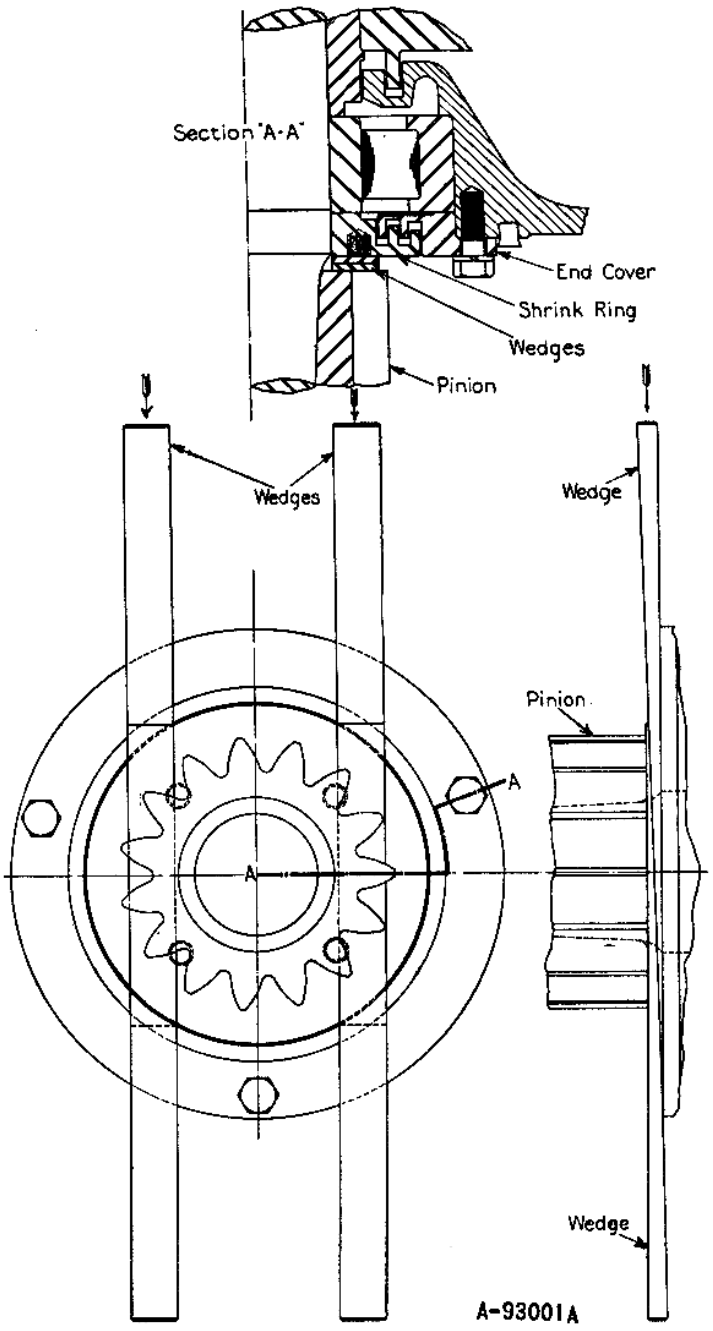
f. Heat pinion in a suitable oven to a temperature of approximately 130° C., above shaft temperature. If the pinion is heated in oil, the bore should be cleaned thoroughly with carbon tetrachloride; to avoid this complication, the use of an oven is recommended instead of heating in oil. A small electric oven, such as household appliance roaster, may be used. Care should be taken to never heat the pinion to more than 190° C., total temperature, or the pinion will be annealed. In no case should boiling water be used to heat the pinion. The temperature rise obtained in boiling water (aprx 80° C.) is entirely too low and would result in pinion slippage.

g. It is recommended that the pinion be heated a few degrees above the required temperature. Attach a thermometer, using putty over the bulb, and wait until the pinion has cooled to the temperature required. Quickly remove thermometer and mount pinion without delay, as described below.

h. Place the heated pinion on the same shaft as it was checked with regarding cold position *(d* above). Without delay, snap the pinion in position, by hand, without the use of a hammer. To control the stresses in the pinion resulting from mounting, the advance from cold position to hot position along the axis of the shaft should be held within the limits of 0.050 inch to 0.055 inch. The actual advance should be checked with the micrometer depth gage at the same points on the circumference as were used when measuring the cold position (d above) .

i. The temperature rise given in f above should be used as a guide only and may have to be varied slightly, depending on conditions, to obtain an advance within the limits specified in h above. If the advance is not within these limits, the pinion should be pulled and remounted.

PINION REMOVAL



1. REMOVE PINION NUT AND APPLY THE FOUR WEDGES. THESE ARE INCLUDED WITH THE MOTOR TOOLS.

2. WEDGES MUST BE SMOOTH AND FREE OF DIRT AND PAINT.COVER WEDGES WITH COATING OF CUP GREASE TO FACILITATE SLIDING ACTION UNDER HEAVY PRESSURE.

3. THE WEDGES SHOULD BE ASSEMBLED AS SHOWN IN !THE ILLUSTRATION, I.E.,TH0SE TO BE DRIVEN $MOULD BE AT THE TOP AND NEXT TO THE MOTOR.

4. APPLY THE WEDGES AS CLOSE TO THE SHAFT AS POSSIBLE TO PREVENT DAMAGE TO THE SEAL POR- TION OF THE SHRINK RING. THE HUB OF THE SHRINK RING IS SOLIDLY BACKED BY THE INNER RACE OF THE BEARING AND BY THE ARMATURE SPI- DER.

5. DO NOT DRIVE THE WEDGES WHICH ARE AD- JACENT TO THE PINION; THESE SHOULD BE STATIONARY, ACTING AS FILLER PIECES ONLY.

6. THE WEDGES ADJACENT TO THE MOTOR SHOULD BE DRIVEN WITH AN ORDINARY MA- CHINIST'S HAMMERI IF POSSIBLE, SIMUL- TANEOUSLY BY TWO MEN. APPLICATION OF HAMMER BLOWS AS INCICATED BY THE AR- ROWS WILL FORCE THE PINION OFF THE SHAFT.

7. IF, DUE TO INACCESSIBILITY UNDER THE LOCOMOTIVE, IT IS IMPOSSIBLE TO AS- SEMBLE THE WEDGES VERTICALLY, AS SHOWN, ANY MORE CONVENIENT ANGLE MAY BE USED. THIS DOES NOT AFFECT ANY DE- TAIL OF THE ASSEMBLY. IT MAY ALSO BE NECESSARY TO REMOVE ONE OR MORE OF THE END COVER BOLTS WHERE THESE WOULD INTERFERE WITH THE OPERATION OF THE WEDGES.

Figure 17. Method of removing pinion from GHM motor.

j. After the pinion is mounted, assemble lockwasher and nut which should be firmly tightened and locked. Speed is not required when assembling these parts because the pinion will stay at the exact position reached when snapped on the shaft. Advance readings will be taken without lockwasher and nut.

89. Armature Removal

a. The armature is removed by sliding it out through the pinion end of the frame. To perform this, it is not necessary to remove the pinion end framehead and bearings, as these parts can be removed in a unit with the armature.

b. First, remove the commutator end framehead in order to be able to support the armature properly while sliding it out to avoid striking on the pole pieces and damaging the armature windings.

c. To remove the commutator end framehead, remove the framehead bolts and pull the framehead out of its fit in the frame by using two $^{3}/4$-inch bolts. The commutator end armature bearing, a Hyatt roller bearing, is separable so that the commutator end framehead can readily be drawn out after the armature is supported by a rope around the commutator.

d. Before sliding the armature out, be sure that the brushes are removed and that the armature is properly supported at the commutator end by a suitable pipe over the shaft extension.

e. Remove the bolts, holding the pinion end framehead to the motor frame. Use two $^{3}/4$-inch bolts, and draw the armature with the pinion end framehead and bearing out of the motor frame.

90. Removal of Pinion End Framehead and Bearing from Armature

Remove the pinion as described in Figure 17. Remove the bearing retaining ring, which is shrunk on the armature shaft. Suitable puller parts are furnished with the motor tools. These parts are arranged for the pulling of the shrink ring and, in a similar setup, for the pulling of the framehead with the bearing. Remove the end cover which is bolted on to the framehead. Mount the puller. Pull the, framehead together with the bearing by turning and tapping of the jack screw.

91. Reassembling of Motor

a. The roller bearings should be taken apart and thoroughly cleaned in kerosene or other petroleum cleaner. In addition to a visual inspection of the bearings, they should be checked for defects by rotating in the hand and feeling for grit or binding. Immediately after bearings have been cleaned in the solvent, they should be further washed in light mineral lubricating oil of SAE-10 grade heated to a temperature of 90° C.

b. Repack bearings with fresh grease (LO 55*1263).*

c. Slip the pinion end framehead over the shaft. Press the bearing into position against the shoulder, exerting pressure against the inner bearing race. Do not hammer directly against the race. Bolt the end cover to the framehead. Shrink the bearing retaining ring on the shaft, forcing it as tightly against the inner bearing race as possible. Shrink ring temperature should be approximately *200° C.,* (390° F.).

d. Insert the armature in the frame, being careful not to strike the pole pieces, field coils, or brushholders. Draw the pinion end framehead bolts up tightly. Slip the commutator end framehead and the roller bearing in position, bolting the framehead tightly to the frame. Reassemble the commutator end end-cover to the framehead. Reinsert the brushes and refit the brushes to the commutator if required.

92. Overhauling

a. Before removing motor from the truck, note the amount of clearance between the axle bearing flanges and the wheel hubs. Replace the axle bearing linings, if necessary, and check the air gap to determine the motor bearing wear.

b. Dismount the gear case and thoroughly clean it, putting in fresh grease on reassembly. Drain the oil from the axle bearing and remove the old waste. Clean the oil chambers. When assembling, repack the axle bearings.

c. Remove the armature with the frameheads. Pull off the pinion. Pull off the bearings; clean and inspect same. Thoroughly clean the armature. Inspect the binding and the insulation for looseness or breakage. Give the armature, including the commutator string band, a coat of insulating varnish. If facilities are available, dip armature in insulating varnish and bake it overnight at 100° C., *(212° F.).*

d. Mount the armature in a lathe and turn or sand the commutator, if required, If necessary, make a light cut across it (surface speed 300 ft per min.) and groove the side mica to a depth of 3/64 inch. Clean out the grooves and the outside ends of the commutator bars and make sure there are not short circuits between the bars.

e. Inspect the brushholders for cracked porcelains, worn carbonways, or weak springs, and replace the necessary parts. On assembly, make certain that the brushholder is the proper distance from the commutator. Install new brushes if required.

f. Remove the field coils; clean and dip them in varnish, Electrical-Insulating conforming to MILV-1137A. The coils should then be baked at 100° C., (212° F.) for 9 hours. When replacing the coils, make sure the terminals are adequately surrounded by putty and taped. Clean the inside of the frame and paint it with insulating varnish as specified above. Make sure all motor leads and connections are tight. After coils are reassembled, apply an additional coat of varnish to **field coils, pole pieces, spring** flanges, and cables.

g. On reassembly, see that all nuts and bolts are tight, covers fastened in place, axle bearings repacked with fresh waste and oil, and armature bearings repacked with fresh grease. Fill grease grooves at bore of frameheads with sealing grease. Make sure that all cables are securely tied, and that the brush pigtails are adjusted to prevent short-circuiting to the motor frame.

h. To exclude water, fill the countersinks of the top pole bolts flush with the frame with sealing compound.

93. Repair of Armatures

These armatures are subject to duty of the most severe character, and with the best of care may eventually fail in service. The purpose of these instructions is to outline the correct methods of repairing armatures, insulated with fabric insulation, and in such a way that when again put into service satisfactory results will be assured.

a. Inspection.

(1) Thoroughly examine the armature for external damage to the laminations of the core or insulation of the coils; also look over the commutator carefully to see that the surface is not scored or otherwise injured.

(2) Inspect for grounds by applying a 1000 volt a-c test between the segments and the armature core.

(3) If a partial ground exists, its location can usually be detected by smoke when the application of the voltage is sustained.

(4) In case of short-circuited coils, they can usually be located, as the surfaces of the commutator segments to which they are connected are generally blackened or pitted.

(5) If, however, there is no external evidence of the shorted coil, the upper layer of all loads should be disconnected from the commutator and then with a 125-volt lamp in series, a 125-volt d-c bar-to-bar test should be made to locate it.

b. Disconnecting Commutator. Remove the binding bands over the conductors at the commutator end. Then disconnect the coil leads from the commutator. This may be done by the cold method, using a wedge-shaped drift to force the leads out of the slots; or by the hot method, using a soldering copper. If the cold method is used, the drift should be slightly narrower than the slot in the commutator bar so that the copper segments will not be damaged. After all of the leads have been disconnected from the commutator, the ground may be located, as each coil and each commutator segment can then be tested for insulation from ground.

c. Repair of Commutator. If the trouble is found in the commutator, clean the exposed surfaces thoroughly and examine for defective bars. Repairs may then be made. Apply a bar-to-bar test of 125 volts, direct-current, with a lamp in the circuit, after making repairs to the commutator.

d. Stripping Armature.

(1) If the trouble is found in the coils, strip them from the core, proceeding as follows:

(2) Raise all the top members of the coils out of the slots first, and then pull them back one at a time, thereby removing the bottom members in succession around the core.

e. Insulating the Core. The core head insulation need not be removed if found in good condition, but should be given a few coats of varnish conforming to MIL-V-1137A followed by baking. If the insulation is damaged or badly charred, remove it and replace with new core insulation. This core insulation may be obtained ready-cut to shape and in the exact quantity of pieces necessary for reinsulating the armature core. Use shellac when cementing to the core the pieces of cut insulation and the layers of binding tape used in building up the space in forming the coil seat.

Finish the surface with at least two applications of shellac as directed above. Thoroughly inspect the laminations which constitute the core proper, and repair any uneven or damaged portions, so that the slots are perfectly smooth, as any projections of metal into the slots may injure the insulation of the coils when they are being assembled on the core.

94. Maintenance Data for Type GHM-838D1-250 Volt Motor

a. Resistance at 25° C.

(1)	Exciting field ----------	0.0117 ohm
(2)	Commutating field ----------	0.0097 ohm
(3)	Armature ----------	0.0195 ohm
(4)	Total ----------	0.0409 ohm

b. Limits of Bearing Wear.

(1) Armature bearings. Armature bearings are roller bearings. No measurable wear can be given. These bearings are to be replaced as soon as they appear loose, allowing radial motion of shaft of approximately 0.020 inch total.

(2) *Suspension bearings.* Axle linings should be replaced when total end play of motor exceeds five-sixteenths inch or total clearance on diameter exceeds three thirty seconds inch in order to restrict spread of gear centers with resulting rapid wear of gearing.

e. Brush Pressure. 7 1/2 to 8 pounds.

d. Permanent Armature Binding. Use tinned steel wire.

(1) Size of binding wire ---------- 0.072 inch.
(2) Pounds tension:

(a) End bands -------- 450 to 500 pounds.

(b) Core bands ------ 250 to 300 pounds.

Section VII. CONTROL EQUIPMENT

95. 17KC27A1 Controller

a. This controller consists of a small drum with three phosphor bronze fingers mounted in a box with a removable cover.

b. It is operated by means of a removable lever, and serves to control the position of the reverser, and hence the direction of locomotive movement.

c. The fingers should be tested periodically to see that they have sufficient pressure on the drum contacts to insure good contact.

d. A thin film of grease should be applied to the cylinder for lubrication at inspection periods to prevent cutting of the fingers and segments. Care should be taken not to use too much lubricant as it will collect under the fingers and cause poor contact.

e. Fingers should be renewed when worn down about half way at the contact point or after such time as the fingers do not provide satisfactory starwheel action.

f. The controller is mechanically interlocked with the throttle mechanism to prevent moving the controller handle at all times except when the throttle handle is in the off or idling position. It should, however, be possible to move the throttle handle at all times regardless of the controller handle position. This interlocking should be checked at inspection periods to see that it is working properly.

96. ME-78-C2 Reverser

a. This reverser is operated by a double cylinder air engine controlled by two "on" type magnet valves. The reverser is interlocked so that it cannot be thrown except with the motor contactors open. As the reverser does not break any current, no roughness should be caused by burning. Any roughness that may develop due to other causes should be removed with a file.

b. Frequent inspection should be made to guard against weak fingers, poor contacts, and loose connections. The contacts should be cleaned when necessary and lubricated with a thin film of grease.

c. The reverser should be tested for operation by pressing the valve pin in the top of the magnet valves. If the operation is slow and the segments and bearings are well lubricated, the cylinders are probably dry and will require oiling. Sluggish action of the reverser may also be caused by sticking or leaking magnet valves.

d. All main contact adjusting studs should be periodically inspected to insure that proper contact is always obtained between the fingers and segments. While the contact

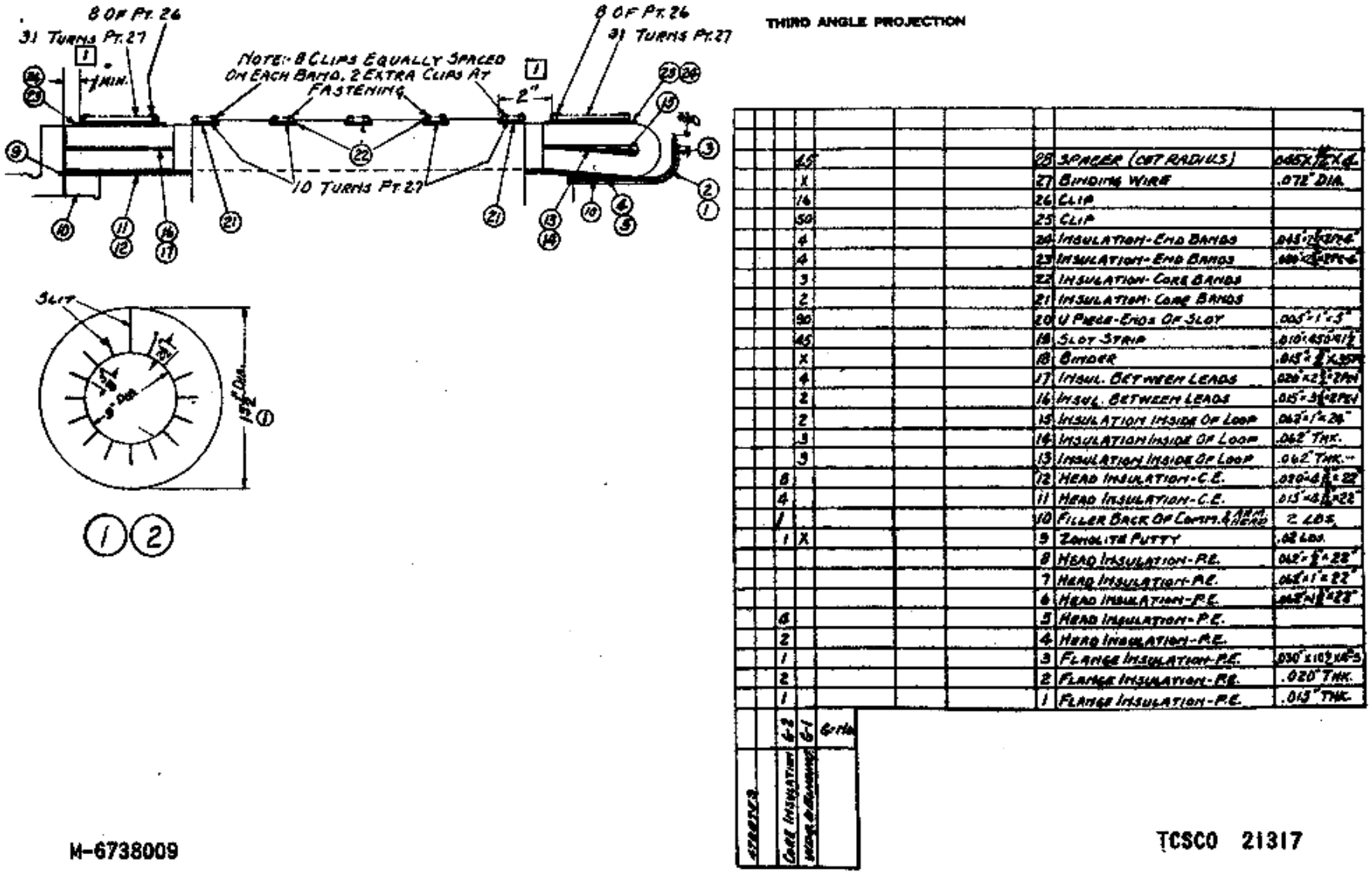


Figure 18. Armature winding insulation, GHM motor.

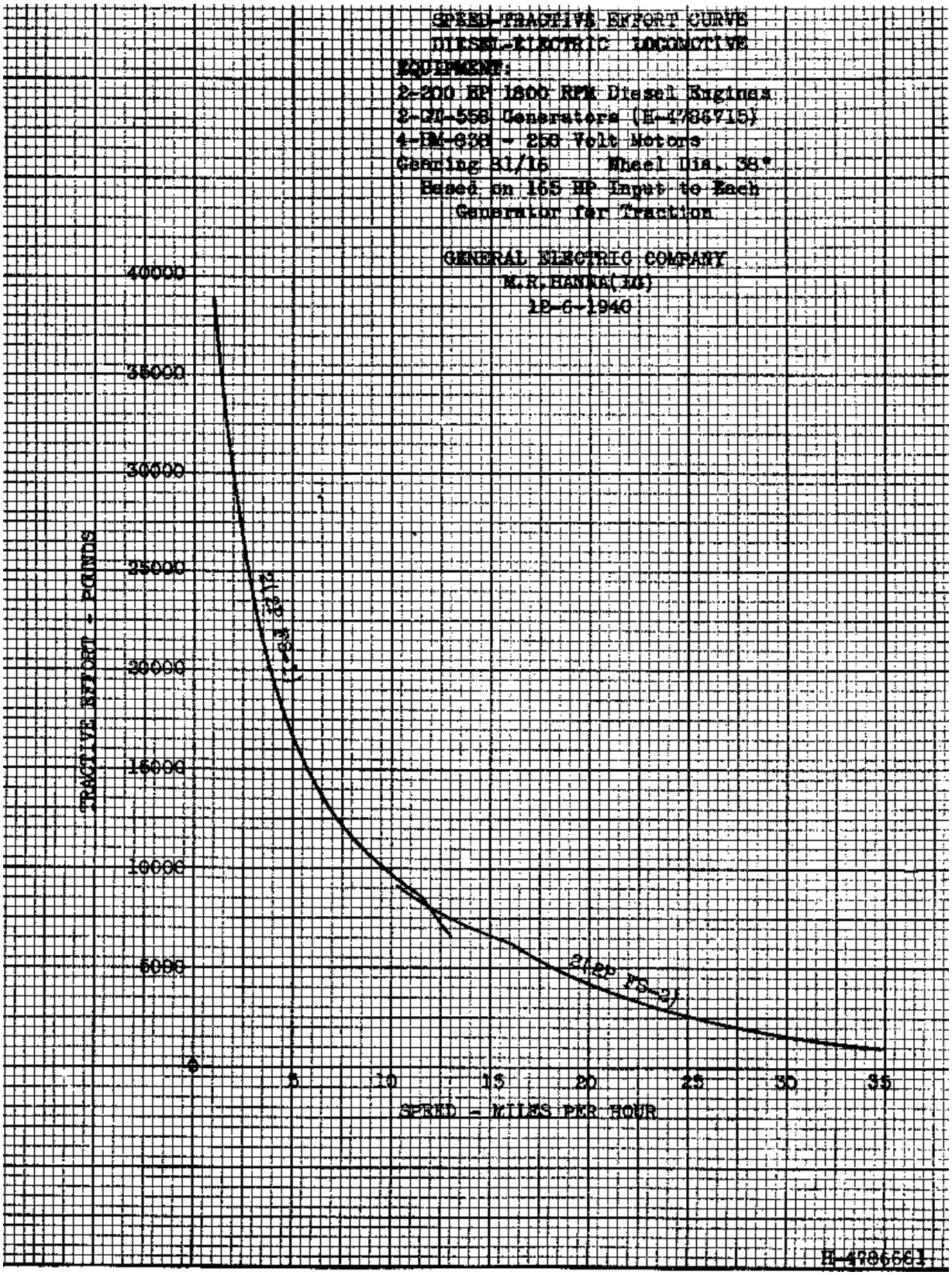


Figure 19. Speed tractive effort curve scale.

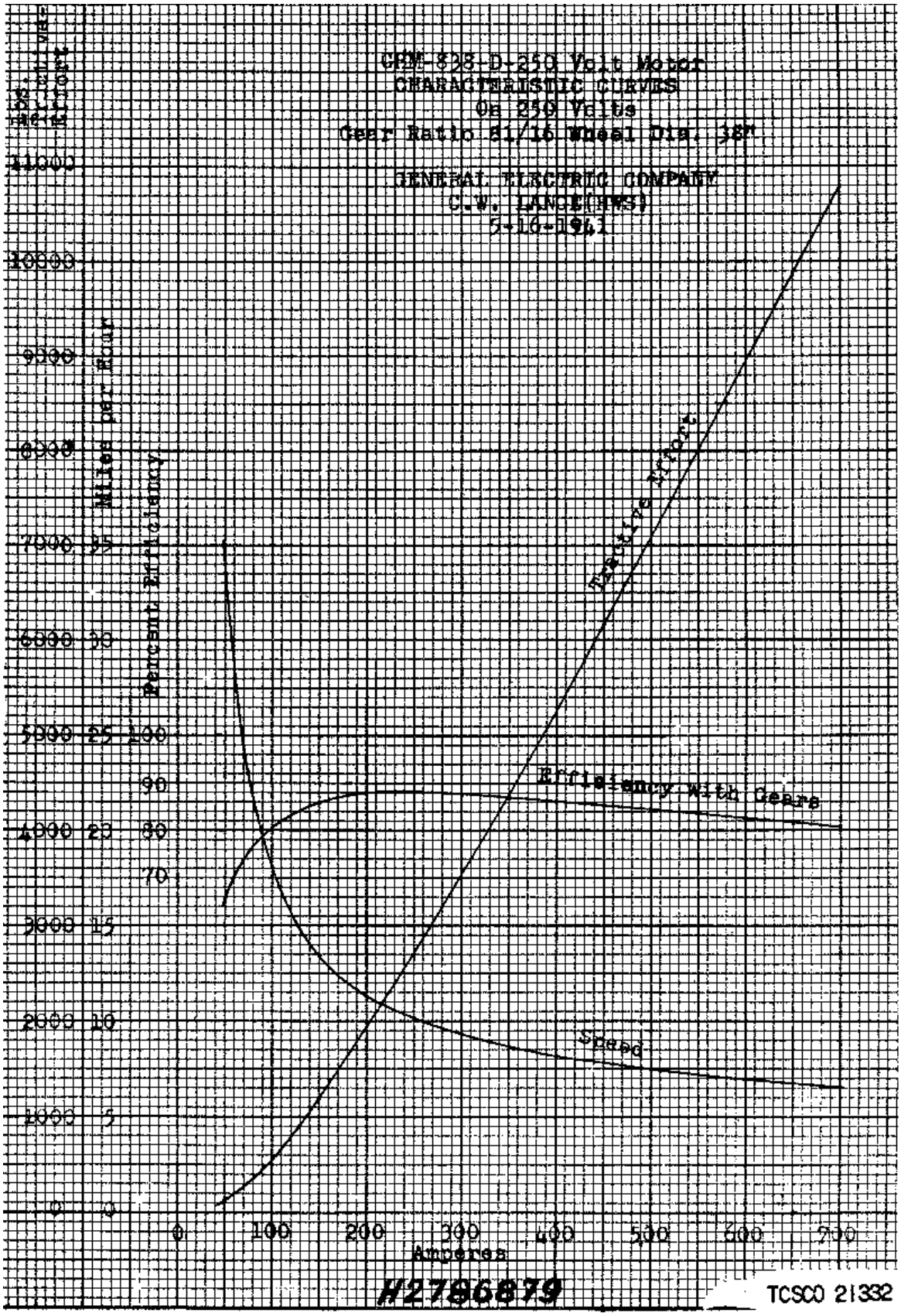


Figure 20. Motor characteristic curve scale.

tip pressures also can be varied slightly by adjusting screws, they should not be used for this purpose, but only used for adjustment to compensate for finger wear. When properly adjusted, the tip pressures should come within the limits specified in paragraph 97. Weak or broken finger springs should be replaced. The following procedures will be followed:

(1) Place strip of thin paper between the individual fingers and segments.

(2) Turn back the adjusting screws until paper can be easily pulled out.

(3) Turn down the adjusting screw until space between finger and locking plate is twenty-seven thirty-seconds inch.

e. All control fingers should be periodically inspected to insure that they are making proper contact and adjusted to drop the proper amount when leaving the segment. This will produce the proper pressure unless the spring is at fault, in which case it should be renewed.

f. For the care and adjustment of the magnet valves used on this reverser, see the instructions given in paragraph 98.

97. Data-ME-78-C2 Reverser

a. Capacity. 400 amperes continuous. *b. Main Contact Data.*

(1) Finger pressure on segment. 15 to 20 pounds for each individual finger.

(2) Wear allowance. 1/g inch.

c. Control Finger Data.

(1) Finger pressure on segment. 2 to 5 pounds.

(2) *Wear allowance.* Half way through.

(3) *Permissible drop when leaving segments.* 3/32 to 1/8 inch.

d. Magnet Valve Coil Data.

(1) G. E. No ---------- 205158

(2) Resistance at 25° C---------- 145 ohms 98. **Magnet Valves**

a. The following instructions cover the care and maintenance of the magnet valves which are used to actuate the reverser. These valves are all of the "on" type. The cross-sectional view of the open and inclosed coil valve is shown in figures 21 and 22.

b. This valve is of the double-acting type and has an inlet and an exhaust port, as well as a port for connecting to the operating cylinder.

c. This valve is so constructed that when the coil is energized the exhaust port is closed and the inlet port is open, thus admitting air from the reservoir to the operating cylinder. When the coil is deenergized, the inlet port is closed and the exhaust port is open and thus connects the cylinder to atmosphere.

d. When the valves are sticky, they should be washed with kerosene or other petroleum cleaner. Also pour a little kerosene or other petroleum cleaner through the magnet core to clean the valve seat. When valves are removed, care should be taken to insure that each valve is returned to its own seat, as each stem is ground to fit its own seat.

e. When a new valve is installed, or when repairing a leaky valve, it must be ground in. After a good seat is obtained all of the grinding material should be blown out with air and the valve washed with kerosene or other petroleum cleaner. When a large number of valves are to be ground, the cost may be reduced by using special reamers in the valves and valve seats before the valves are ground in.

f. The air gap and travel of the magnet valve should be periodically measured. Gap gage GE. 1499733 (figs. 25 and 26) is arranged with four measuring gaps and should be used for this check. This also applies to the adjustment of new valves. The measurements are made by removing the magnet valve cover and armature. The 0.032-inch gap of the gage is placed over the upper stem or plunger and pressed down. This should seat the exhaust valve; that is, air should not escape through the exhaust valve. If air passes through, new valves should be installed.

g. The valve travel is stamped on the bottom surface of the cap plug on the magnet valves.

h. When installing new valves, the following measurements should be taken, using gap gage, GE. 1499733:

(1) Place the 0.052-inch gap over the exhaust valve stem and press down. If the valve stem is of the correct length, the exhaust valve will seat and air will not pass through it, and the legs of the gage will rest on top of the magnet core. If these conditions are not satisfied, the valve stem should be lengthened or shortened. When the exhaust valve stem is found to be too short, it can be lengthened a trifle by care fully peening the upper end. After the

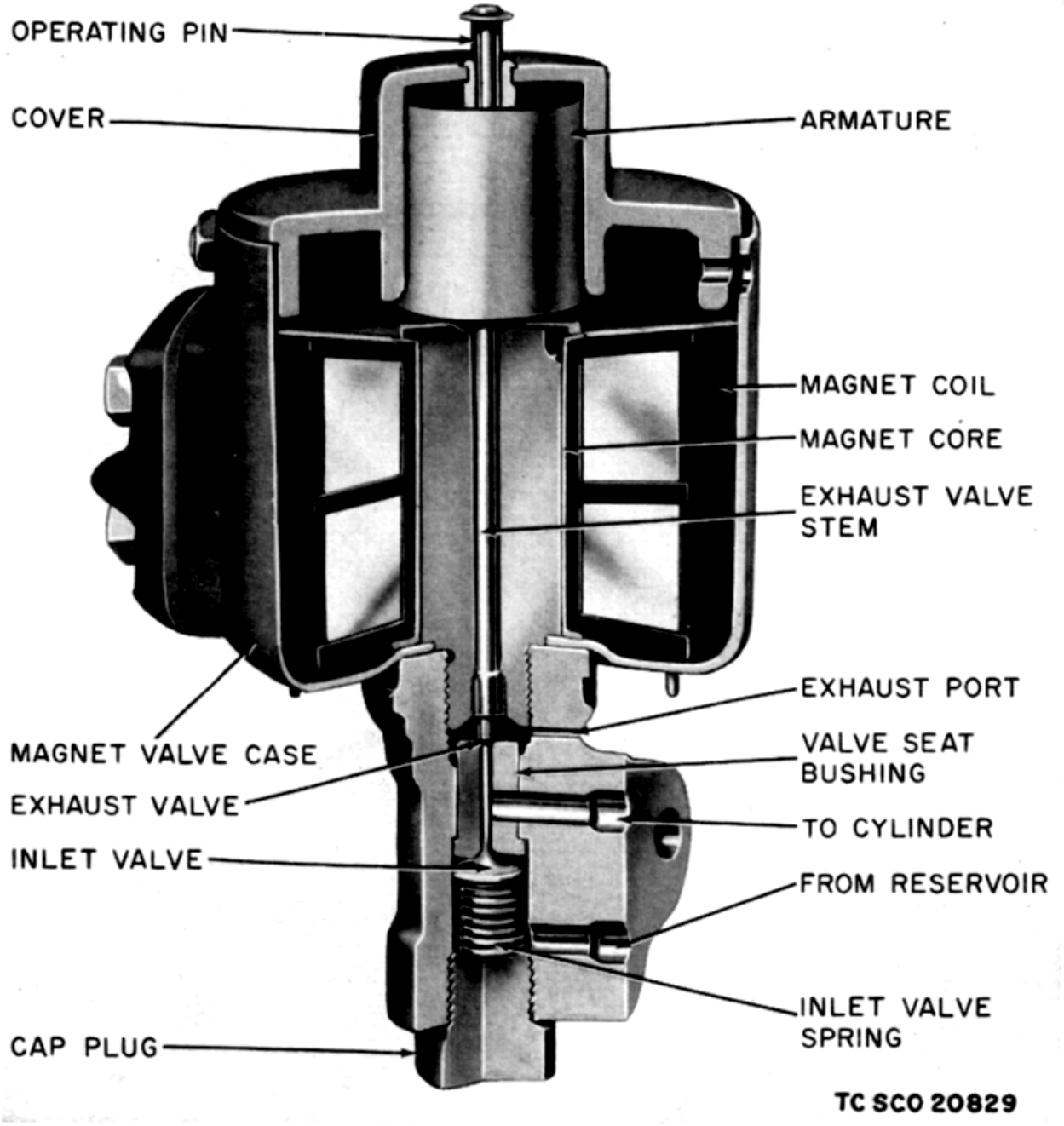


Figure 21. Inclosed coil "On" type magnet valve.

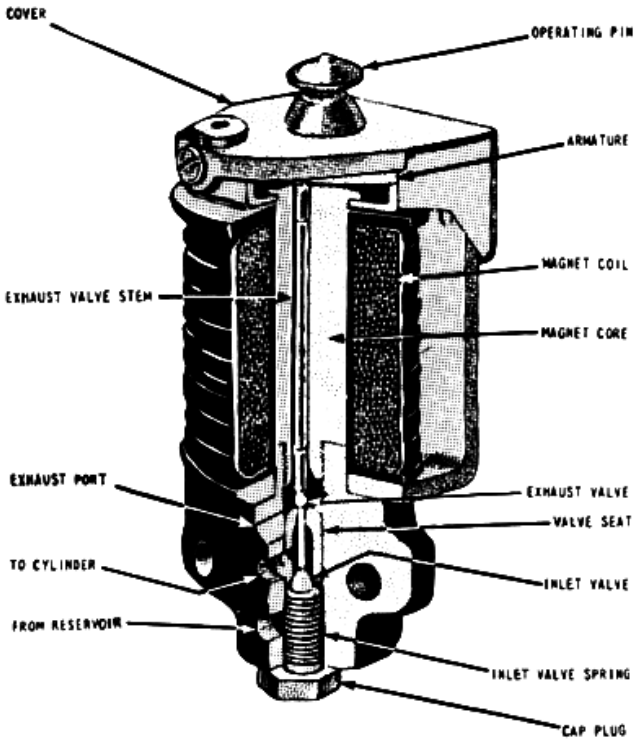


Figure 22. Opt Open coil "On" type magnet valve.

Figure -23. Micrometer dial gage for adjusting magnet valve.

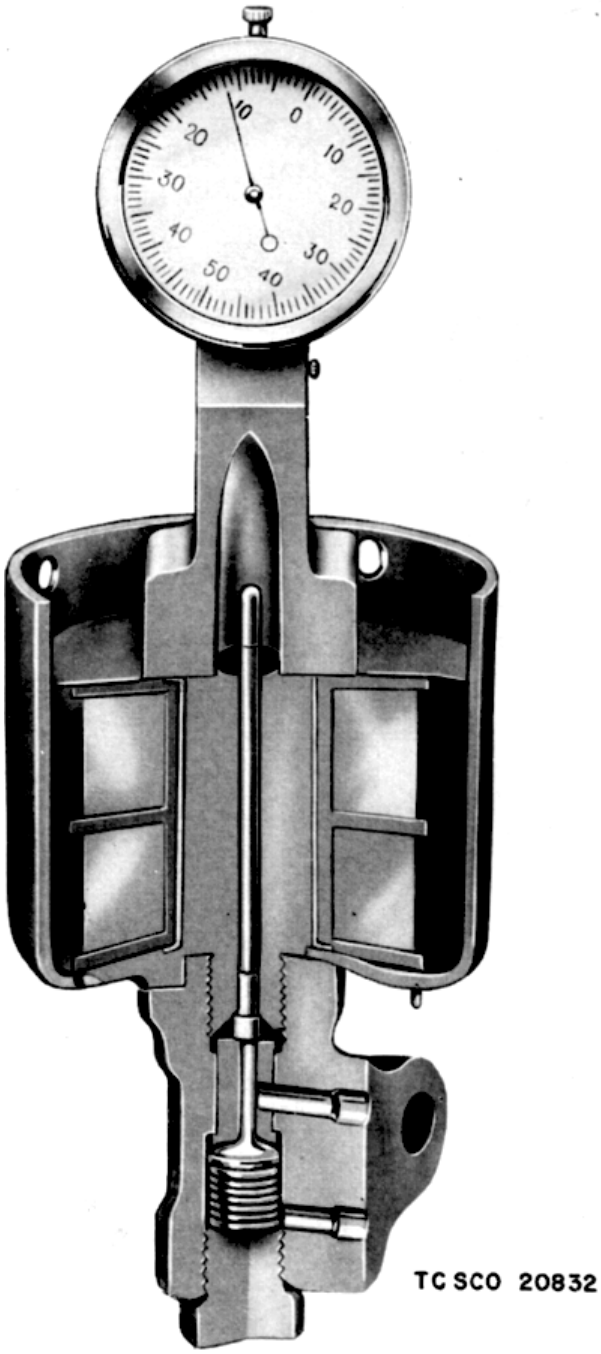


Figure 24. Method of using micrometer dial gage.

exhaust valve seat has been ground in a number of times, it may be found that an exhaust valve stem of standard length is too short, and the adjustment called for above cannot be obtained. In this case an over-length valve stem should be used. Valve stems are supplied $^{1}/_{16}$ inch longer than the ones furnished with new valves.

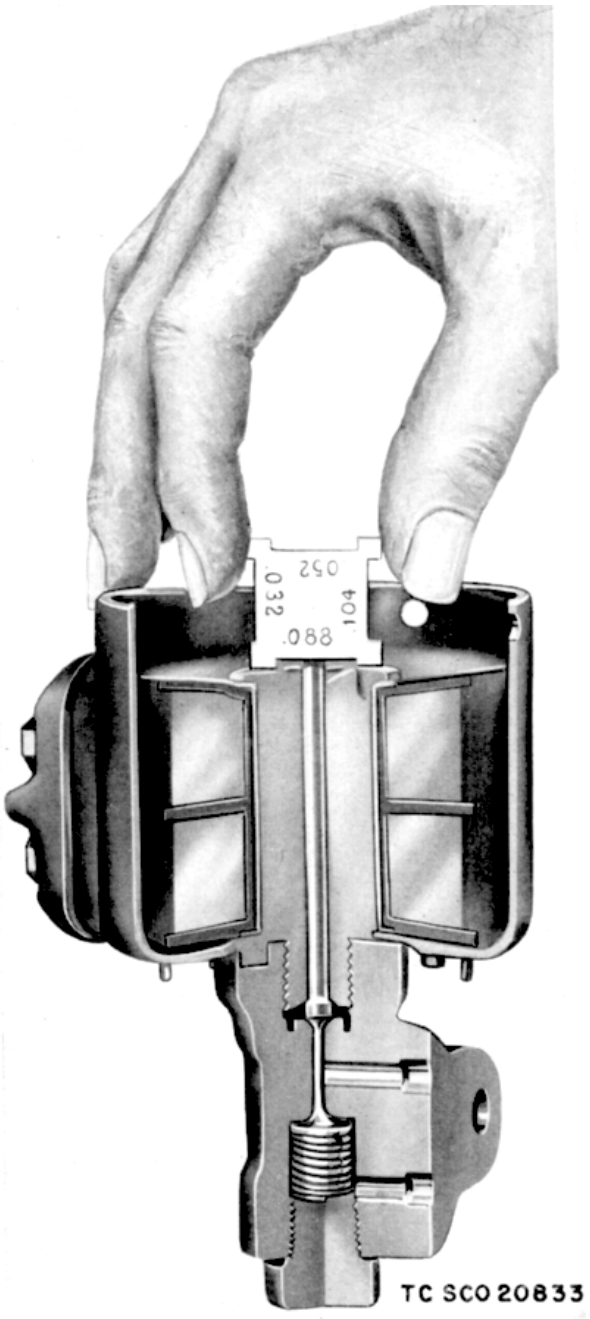


Figure 25. Enclosed coil "On" type magnet valve, gage in proper place for checking valve stem travel.

(2) Use 0.088-inch gap for valves with 0.036-inch travel; 0.104-inch gal) for valve with 0.052-inch travel. Place the proper gap over the exhaust valve stem with the gage legs resting on the magnet core top. If the inlet valve stem is of the proper length, the upper or exhaust valve stem will be flush with the gap surface and air will not pass through the inlet valve. If air passes through the inlet valve, remove a small amount from the inlet valve stem. If there is a space between the top of the exhaust (upper) valve stem and gage gap, install an inlet valve with a longer stem.

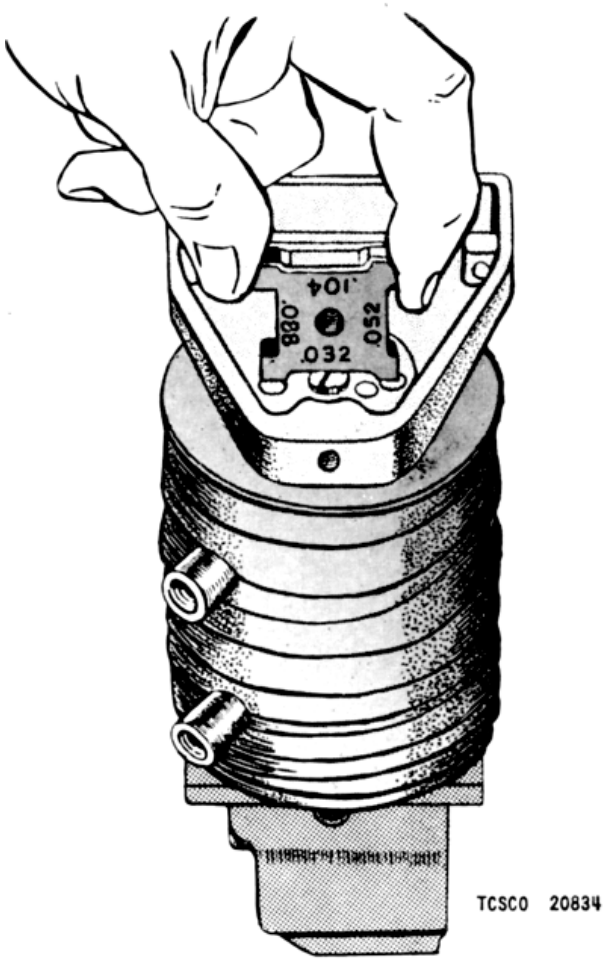


Figure 26. Open coil "On" type magnet valve, gage in proper place for checking valve stem travel.

i. To check worn valves, place the 0.032-inch gap over the exhaust valve stem and pros down. If the exhaust valve does not scat (that is, air passes through the valve), install a new valve and take measurements as described above.

j. In order to do this work quickly, remove the magnet valve from the apparatus. This can be done quite readily by taking out the two cap bolts near the bottom of the valve.

k. A more accurate method of measuring valves

is by the use of a standard micrometer gage with a special fixture (fig. 23). The method of using this gage is illustrated in figure 24. This is especially convenient where there are a large number of valves to be overhauled, as the amount of material to be removed from new valves can be determined directly rather than by a cut and try process.

l. The proper valve stem lengths as measured above the magnet valve core are as given above and in paragraph 99.

99. Magnet Valve Data

a.

OE type or No.	*Travel*	*GE. No.*	*Operating coil Resistance at 25 C.*	*current to operate at Air Pressure*	*Continuous Current*	*Apparatus used on*
205157	0.036 in.	205158	145 ohms	0.093 amp at 100 1b.	0.34 amp.	ME-78-C2 reverser

b. Four sided measuring gage — GE 1499733
c. Wrench for magnet core — GE 260513
d. Micrometer gage — GE 2812735
e. Gage caps to be used: 0.036-in. travel
(1) New Valves:
(a) Valve de-energized — 0.088 in.
(b) Valve energized — 0.052 in.
(2) Worn Valves:
Wear limit — 0.032 in.

f. The above valves are all to be measured by having the legs of the gage rest on top of the magnet core.

100. Type 17CM Contactors

a. These contactors are light weight, single pole, magnetically operated with a bent-up frame construction and using a straight armature with rocker bearing. The contactor must be mounted with its supporting base in a vertical plane and with its contact tips up.

b. Where necessary, the contactors are provided with blowout coils and are chutes to assist in rupturing the are. The are chute is easily moved, thus making the contact tips readily accessible.

c. The contactor should be manually operated during inspections to detect any mechanical difficulties. Care should be taken that all circuits are de-energized before manually closing or doing any work on the contactors.

d. The copper contacts should be kept clean and if they become burned or pitted, they should be dressed up by light applications of a fine file. Extreme care should be taken to insure that full line contact is obtained across and between the two tip surfaces after filing. If the tips are too badly pitted, they should be renewed. The contact tips should also be renewed when worn halfway through.

e. The contacts of the 17CM15HH6 contactors are silver faced and should require little attention. If it becomes necessary to clean the contacts, use a clean lintless cloth wet with carbon tetrachloride or use a fine file. Do not use sandpaper or emery cloth, as these will leave harmful grains in the contact surface. If a file is used, care must be taken not to remove too much material.

f. The 17CM12J15 contactor has non-welding alloy contact tips. These are copper colored and are distinguished from the copper tips by having an S indented in the side. Maintenance should be the same as for copper tips.

g. The contact tip pressure should be checked periodically. To do this, insert a thin piece of paper between the contacts, fully close the armature either mechanically or by energizing the operating coil, and attach a spring balance (with wire or string stirrup if necessary) to the head of the screw holding the movable contact tip. The balance should then be pulled, perpendicular to the line of contact, until the paper can be easily moved. The pull at the instant the paper can be moved is the contact tip pressure. Refer to figure 27.

h. The tip gap and wipe of the contact tips should be checked periodically. The tip gap is the distance between tips when the contactor is fully open. The wipe, which is measured at the line of final tip contact, is a measure of the armature movement after the tips touch. It is the distance that the movable tip would move from its position as it just touches the fixed tip to the position it would assume were the fixed tip not in place when the armature is fully closed against its stop.

i. The contactor is provided with an adjustable armature spring to obtain positive opening when the operating coil is de-energized. This spring was properly adjusted at the factory and should not require any further adjustment. In the event a contactor is disassembled or the adjustment is otherwise disturbed, the operating coil should be connected to a variable voltage source and the pickup current checked against that specified in figure 48.

j. The contact tips should be renewed when worn halfway through or when the silver facing has worn through. The braided copper shunt, which carries the current from the moving contact to the contactor terminal, should be inspected periodically and renewed before it becomes badly worn or broken.

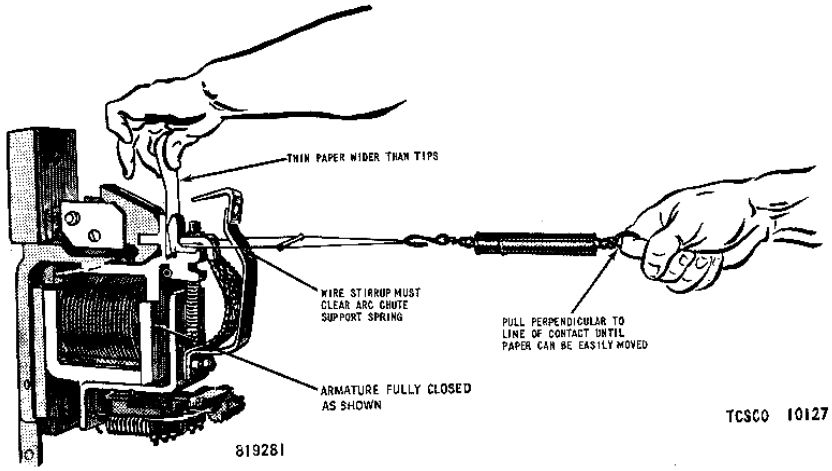

THIN PAPER WIDER THAN TIPS
WIRE STIRRUP MUST CLEAR ARC CHUTE SUPPORT SPRING
PULL PERPENDICULAR TO LINE OF CONTACT UNTIL PAPER CAN BE EASILY MOVED
ARMATURE FULLY CLOSED AS SHOWN
TCSCO 10127
819281

Figure 27. Measuring final contact tip pressure.

101. Data-17 CM Contactors

Contact data								Operating coil data		
Contactor	Symbol on locomotive wiring diagram	Ampere continu-ous capacity	Tip gap or break	Wipe or wear allowance	Initial pressure	Final pressure	Catalog No.	Ohms resist-ante at 25°c.	Approx-imate pick-up amperes	Catalog No. blowout coil
17CM12BE2	P1, P2, P3, P4	350	13/32 to 16/32 in.	11/32 to 13/32 in.	2 ½ to 4 lb	10 to 131b	2738575	38.6	0.45	4739111
17CM12J15	GS1, GS21	275	13/32 to 16/32 in.	11/32 to 13/32 in.	7 to 100 lb	18 to 221b	2738770	6.4	2.0	
17CM15CC29	GF	18	18/32 to 21/32 in.	7/32 to 9/32 in.	1 ½ to 2 lb	3 to 4lb	2738570	73.	.25	
17CM15HH6	Ml, M2, M3, M4	125	11/32 to 13/32 in	5/32 to 7/32 in.	1 ½ to 2 lb	3 to 4 lb	2738570	73.	.25	

102. Interlocks

a. The engine starting contactor is provided with an electrical interlock.

b. This interlock consists essentially of a contact bar attached to the contactor armature through insulation and contact fingers which are attached to the contactor frame through insulation. Contact pressure, contact wipe, and tip gap or break should be checked periodically. It should seldom be necessary to check the exact pressure except when the contact is suspected of being faulty. Wipe, pressure, and break are given in c below. Both the stationary and moving contacts are silver faced and should require very little attention. If it becomes necessary to clean the contacts, use a clean, lintless cloth wet with carbon tetrachloride or use a fine file. Do not use sandpaper or emery cloth as these will leave harmful grains in the contact surface. If a file is used, care should be taken not to remove too much material. Contact parts should be re placed when the silver facing has worn through.

c. Interlock Data.

Contactors used on					
Type	Type	Symbol	Wipe	Tip gap or break	Pressure
17AF14H1	17CM12J15	GS1,GS21	$^{3}/_{32}$ to $^{5}/_{32}$ in.	$^{6}/_{32}$ to $^{9}/_{32}$ *in.*	*8 oz.*

103. Type DB-1663-A Relay

a. The relay is of the magnetic type, having hinged (spring biased) armature. The armature carries an insulation block on which the contact finger is assembled. The finger, which is spring mounted, has a silver contact face making contact with a silver faced stationary contact stud.

b. The DB-1663-A7 relay is used as a motor field shunting control relay and operates as a function of the generator voltage.

c. The pickup voltage can be adjusted (over a limited range) by changing the de-energized position of the armature (and hence the air gap.) This adjustment is obtained by means of an adjustable armature stop. Increasing the opening or air gap increases the pickup voltage.

d. The dropout voltage can also be adjusted by changing the tension of the spring which is attached to the armature, decreasing the tension to lower the dropout voltage and increasing it to raise the dropout voltage. The pickup setting should always be re-checked after any change is made in the dropout setting as it may also be affected.

e. The contacts, being silver faced, should seldom require attention. If it becomes necessary to clean the contacts, use a clean, lintless cloth wet with carbon tetrachloride or use a fine file. Do not use sandpaper or emery cloth, as these will leave harmful grains in the contact surface. If a file is used, care must be taken not to remove too much material. The contacts should be replaced when the silver facing has worn through.

f. The contact tip pressure, gap, and wipe should be periodically checked against the values given below. The wipe of the contacts making when the relay picks up can be adjusted by screwing the stationary contact stud in or out. With proper operating adjustments, the tip gap should always be equal to or greater than the minimum value specified.

(1) Tip gap	1/8-in. min.
(2) Wipe	3/32 in.
(3) Pressure	8 oz. min.

104. Type 17HE9E1 Control Switch

a. Description. This is a cam operated switch having three normally open contacts and two normally closed contacts, with the switch in the idle position, operated by cams mounted on the throttle operating shaft, so that the position of the switch corresponds to the position of the throttle handle. In this manner, the switch is used as a controller, to control the operation of the traction motor and the generator teaser field circuits.

b. Inspection and Maintenance.

(1) All terminals and contacts should be inspected to make sure that they are tight.

(2) The cam shaft should be turned through its operating range to make sure that it turns freely and that good contact is made between the movable fingers and the stationary contacts.

(3) Both stationary and movable contacts have silver contact surfaces and should require little attention. If it becomes necessary to clean the contacts, use a clean lintless cloth wet with carbon tetracholride or use a fine file. Do not use sandpaper or emery cloth, as these will leave harmful grains in the contact surface. If a file is used, care must be taken not to remove too much material. The contacts should be replaced when the silver facing has worn through.

(4) Contact wipe and tip gap should be checked periodically against the values given in below.

(5) 17HE9E1 data

(a) *Tip* Gap	11/32 to 13/32 in.
(b) Drop	3/32 to 1/8 in.
(c) Pressure	3/4 to 1 lb.

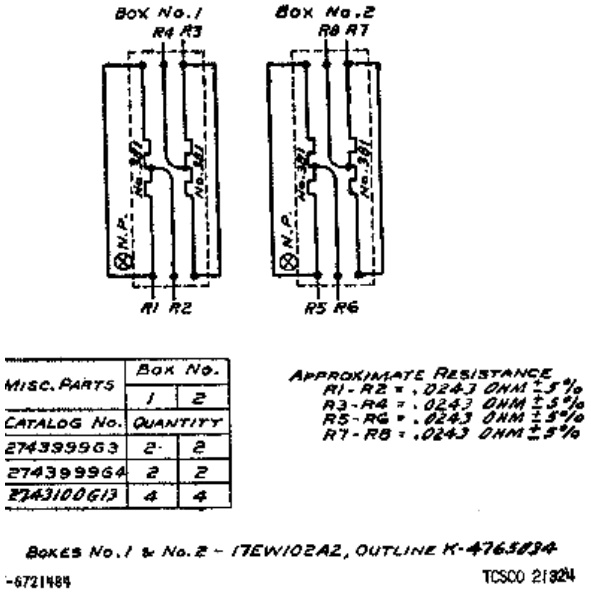
105. Resistors

a. Various types of resistors are used for different circuits. For connections, refer to figures 28, 29, and 48.

b. Type 17EW resistors are furnished for the traction motor field shunting circuits. These resistors should be inspected periodically to insure that the tie rods holding the units in place are tight and that all connections are tight. The insulation between units should be kept clean at all times by blowing out with dry compressed air, being careful that the pressure is not too high.

c. Adjustable type resistors are furnished on type 17FR panels. These resistor panels, when provided, are for the generator field circuit. These resistors should be inspected periodically to insure that the tie rods are tight and that all clips and terminals are tight. The resistor windings should also be inspected to see that they are not broken or nicked, or have any short circuited turns. Replace porcelain tubes if they are cracked or broken.

d. Vitreous enameled resistor tubes are also provided for generator field, light, and heater circuits, these being mounted on type 17FR panels. These resistors should be examined periodically to insure that the terminals are tight and that the tubes have not been broken or damaged.



Misc. Parts	Box No.	
	1	2
Catalog No.	Quantity	
274399963	2	2
274399964	2	2
2743100613	4	4

Approximate Resistance
R1-R2 = .0243 ohm ±5%
R3-R4 = .0243 ohm ±5%
R5-R6 = .0243 ohm ±5%
R7-R8 = .0243 ohm ±5%

Boxes No.1 & No.2 - 17EW102A2, Outline K-4765034

-6721484 TCSCO 21324

Figure 28. Connection diagram, EW resistor.

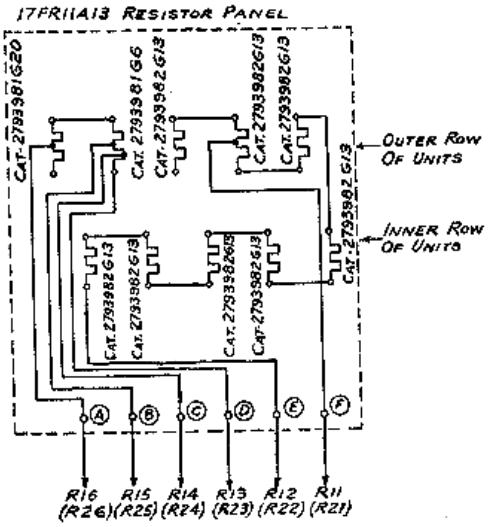
106. **Type DO-47 Instruments**

a. These instruments operate on the D'Arsonval principle, using a permanent magnet for the field and a coil on the moving element for the armature.

b. These instruments should be periodically inspected to insure that the terminals are tight, that the pointers are on zero, and that the pointers do not stick.

c. The pointer may be set on zero by turning the small screw which is located on the front of the cover. This screw, by means of a small cam, changes the position of the metal piece to which the coil spring is attached, thus changing the tension on the spring and moving the zero position of the pointer accordingly.

d. The pointer may be tested for sticking by electrically obtaining maximum deflection and then noting results when the circuit is broken. If the pointer does not readily return to zero, the instrument should be removed for cleaning and calibration.



Approximate Resistance
R11-R12 = R21-R22 = 25.3 Ohms
R13-R14 = R23-R24 = 5.0 Ohms
R14-R15 = R24-R25 = 5.0 Ohms
R15-R16 = R25-R26 = 23.0 To 75.0 Ohms

Note:
Where Internal Connections Are Made To The Adjustable Slider Terminals, The Connecting Wires Should Be Made Long Enough So That The Slider May Be Moved To Any Point On The Tube To Which It Is Attached, Or To Any Point On The Next Tube On Either Side.

K-6724139 TCSCO 21325

Figure 29. Connection diagram, 17FR11A13 resistor panel.

e. No attempt should be made to adjust or remove the instrument from the circuit unless it is certain that the current is off, as the terminals and the elements of the instruments are alive.

f. Where external shunts are used with ammeters, the ammeter must be calibrated with a shunt of the same current and millivolt rating as the shunt with which it is to be used. The shunt leads must also be of approximately the same resistance as that of the leads with which the ammeter is to be used.

g. Install shunts so that metallic dirt or dust cannot get on the resistance strip and short circuit the shunt. Keep terminal screws tight at all times. Do not allow leads to become wet and thus short circuited. Artificial ventilation is not required. The temperature rise may be from 40° to 50° C., (72° to 90° F.) above the ambient and there should be enough ventilation to take care of this rise.

h. Where voltmeters are provided with external resistors, care must be taken that the voltmeter is calibrated and used with its external resistor.

Section VIII. TYPE 2022-G or 2023-G GENERATOR

107. Characteristics

The generator, rated at 20 to 21 amperes, 32 to 40 volts at 900 rpm, is a direct-current, four-brush, shunt-wound engine-driven unit. Looking at the driven end, the units are connected internally for clockwise rotation for the type 2022-G generator, and counterclockwise for the type 2023-G (fig. 30). It is connected to a type 1800R16 Leece-Neville voltage control unit. This generator is used for charging a 16 cell, lead acid type battery and provides current for lighting and control equipment. For internal wiring diagram for generator 2022-G or 2023-G, see figure 30. For operation of generators in parallel, see figure 31.

108. Inspection

Apparatus should be inspected often enough to prevent failure in service. This should include

a. Cleaning. It is essential that the apparatus be kept clean at all times. At least once a month, blow dirt or brush dust out of the commutator-end housing (10) and brush rigging (11) (fig. 30) with dry compressed air.

b. Commutator. Inspect for roughness or eccentricity. If using No. 00 sandpaper does not correct this, or if the mica does or is about to project above the copper segment surface, the commutator must be resurfaced as described in paragraph 109.

c. Brushes and Brush Holders. Check periodically for wear, proper spring pressure, and that brushes are free in the brush holders. When brushes are worn down to $^{11}/_{16}$-inch lengths, it is advisable to use the second notch of the levers. Refer to paragraph *111f* for spring pressures. Also check for loose, shorted, or grounded connections.

d. Lubrication. Lubricate generator bearings (3 and 34, fig. 30) in accordance with LO 55-1263 (fig. 50). Do not lubricate excessively as oil may enter the generator and cause failures.

109. Commutator Maintenance

If the commutator is rough, burned, or eccentric, it must be resurfaced in a lathe. Turn off only enough copper to leave a uniformly true surface. The minimum diameter to which the commutator can be turned is $2\ ^{19}/_{32}$ inches. The new diameter is $2^{3}/_{4}$ inches. Do not turn off any copper from the commutator risers (42, fig. 30). After the commutator is turned, carefully undercut the mica insulation between the copper segments to a depth of 0.030 inch. The sharp edges of the bars should be removed with a hand scraper or knife. Smooth and polish the commutator surface with fine sandpaper. Test armature for short circuits.

110. Generator Disassembly (fig. 30)

a. Make adjacent center punch marks on housings (10 and 22) and field ring (20) so that these marks can be lined up in assembly to locate the parts in their original position.

b. Remove brush opening band (40).

c. Lift up levers (13) to relieve spring pressure, taking care not to snap them, which will damage the brushes.

d. Now brushes (12) may be removed from brush holders (14). Do not pull pigtails out of brushes. e. Remove screws (1), bearing retainer (2), bearing retainer nut (5), and nut lockwasher (6). Do not remove flat head screws (46).

f. Remove driven-end housing screws (33).

g. With a brass rod held against exposed commutator-end of armature shaft at (4), drive the shaft out of roller bearing (3).

h. The armature (38) with driven-end housing assembly (22) will now be free.

i. Place armature (38) in a bench vise and remove screws (31), bearing retainer (26), bearing retainer nut (29), nut lockwasher (28), and spacing collar (30). Do not remove flat head screws (37).

j. Press armature (38) out of driven-end ball bearing (34).

k. Disconnect all internal connections from brush rigging (11).

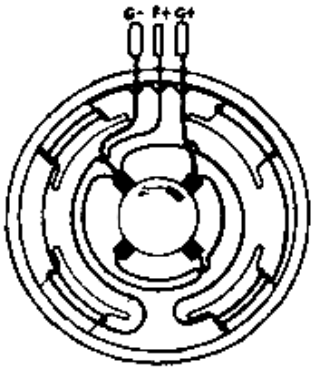
l. Remove screws (39) and take away commutator-end housing (10).

m. Removal of two square head screws through two are shaped slots in outer face of commutatorend housing (10) will release brush rigging (11).

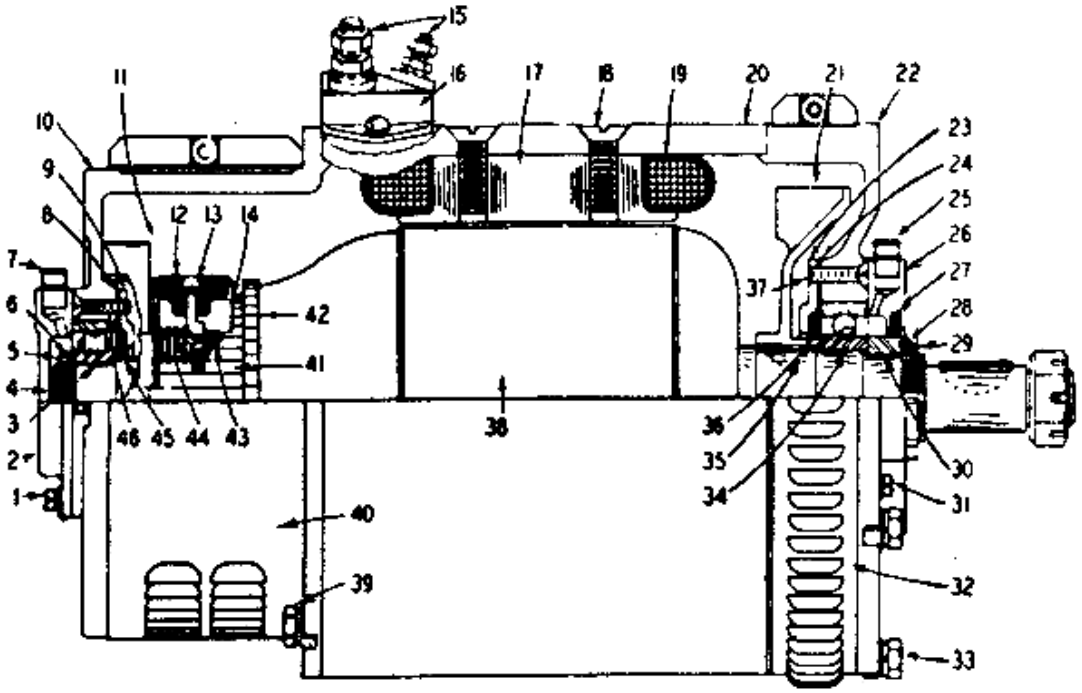
n. Removal of flat head screws (37 and 46) will release the inner bearing retainers at the drivenend and commutator-end.

o. Do not disassemble pole pieces (17) and field coils (19) from field ring (20) unless the field coils have to be replaced.

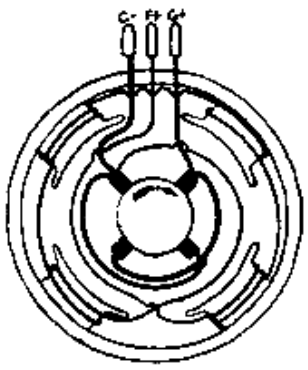
TYPE
2022-G



INTERNAL WIRING DIAGRAM
LOOKING AT COMMUTATOR END



TYPE
2023-G



INTERNAL WIRING DIAGRAM
LOOKING AT COMMUTATOR END

1 - RETAINER SCREWS
2 - COMMUTATOR END OUTER BEARING RETAINER
3 - ROLLER BEARING
4 - COMMUTATOR END OF ARMATURE SHAFT
5 - BEARING NUT
6 - NUT LOCKWASHER
7 - COMMUTATOR END OILER
8 - COMMUTATOR END INNER BEARING RETAINER
9 - FELT WASHER RETAINER
10 - COMMUTATOR END HOUSING
11 - BRUSH RIGGING
12 - BRUSHES - FOUR
13 - BRUSH LEVER
14 - BRUSH HOLDERS - FOUR
15 - TERMINALS
16 - TERMINAL CARRIER
17 - POLE PIECES- FOUR
18 - POLE PIECE SCREWS
19 - FIELD COILS - FOUR
20 - FIELD RING
21 - VENTILATING FAN
22 - DRIVEN END HOUSING
23 - FELT WASHER RETAINER
24 - DRIVEN END INNER BEARING RETAINER
25 - DRIVEN END OILER
26 - DRIVEN END OUTER BEARING RETAINER
27 - FELT WASHER
28 - NUT LOCKEASHER
29 - BEARING NUT
30 - DRIVEN END SPACING COLLAR
31 - RETAINER SCREWS
32 - FAN VENT SHIELD
33 - DRIVEN END HOUSING SCREWS
34 - BALL BEARING
35 - FAN KEY
36 - FELT WASHER
37 - INNER RETAINING SCREWS
38 - ARMATURE
39 - COMMUTATOR END HOUSING SCREWS
40 - BRUSH OPENING BAND
41 - COMMUTATOR
42 - COMMUTATOR RISERS
43 - BRUSH SPRING
44 - FIRST NOTCH OF BRUSH LEVER
45 - FELT WASHER
46 - INNER RETAINER SCREWS

Figure 80. Sectional illustration and wiring diagram.

111. Generator Reassembly (fig. 30)

a. Clean all parts before reassembly.

b. Carefully inspect to determine if any repairs or replacements are necessary.

c. Test armature and field coils for ground, with test lamp using alternating current (110 volt, 60 cycle).

d. Field coils are connected in series and have a resistance of 21.5 ohms ± 0.5 ohm. At 32 volts the current will be from 1.45 to 1.5 amperes. Replace armature or field coils if necessary.

e. Discard brushes (12) when worn down to 9/16-inch length for full diameter commutator or 5/8-inch length for minimum commutator diameter. New brushes are thirteen sixteenths inch long.

f. The brush spring pressure range is 3 to 3 1/4 pounds up to the 4th notch of the brush lever.

g. For reassembly, reverse the procedure outlined in disassembly but note following instructions.

h. Make certain that the pilot diameters, matching diameters, and facings on housings and field rings are not nicked or burred to insure proper alinement.

i. Use new felt washers (45) and saturate them in No. 6 Keystone Condensed Oil medium or equal. j. Use new tabbed and spring lockwashers under all hex and square head screws: Make certain that the spring lockwashers are next to the screw heads. k. Pack bearings (3 and 34) in accordance with LO 55-1263 (fig. 50).

l. Attach inner bearing retainer (8) to commutator-end housing (10) with flat head screws (46). Attach brush rigging (11) with two square head screws and their tabbed lockwashers. Do not install brushes at this time.

m. Start straight and press in roller bearing (3), then hold bearing in place with a temporary steel outer retainer made 1/8 inch thick with its outside diameter 2 7/8 inches. A hole 11/8 inches in diameter is to be punched in the center and four holes drilled with No. 15 drill (.180) spaced equidistantly from each other on the circumference of a circle having a radius of 1 7/32 inches.

n. Fasten this commutator-end housing assembly on the field ring assembly (20) with screws (39) and both spring and tabbed lockwashers.

o. Attach inner bearing retainers (23 and 24) and oil saturated felt washer (36) to driven-end housing (22) with flat head screws (37).

p. Start straight and press ball bearing (34) in place. Put fan key (35) in place and press fan (21) to stop shoulder on armature shaft. Press armature (38) into bearing in driven-end assembly, using a tubular drift against the inner race to prevent damaging the bearing.

q. Slide the armature and driven-end housing assembly into the field ring and commutator-end housing assembly. Drive the armature shaft in the roller bearing with a lead hammer, hitting alternately on the shaft and round the edge of the housing. Make certain the pilot diameter of drivenend housing (22) enters the field ring (20). Fasten housing (22) to field ring (20) with screws (33) and both spring and tabbed lockwasher.

r. Remove temporary steel outer retainer and proceed with the rest of the assembly.

Section IX. GENERATOR CONTROL UNIT TYPE 1800-R16 REGULATOR

112. General Inspection

It is recommended that the generators and regulators be inspected every 30 days or every 500 operating hours, whichever occurs first.

a. Disconnect the parallel connection, by disconnecting the wire that is connected to the P + terminal on the regulator.

b. Make certain the opposite unit of a parallel connection is at rest while testing.

.

c. Remove the generator battery fuse.

d. Connect the voltmeter between the regulator side of the fuse clip (B-) and a ground (B+).

e. For a true reading, accelerate and retard the engine several times. Take a voltage reading each time the engine is running at top speed. The voltage reading should be from 37.5 to 38.0 volts at full throttle.

f. Check the contacts for burned or pitted spots

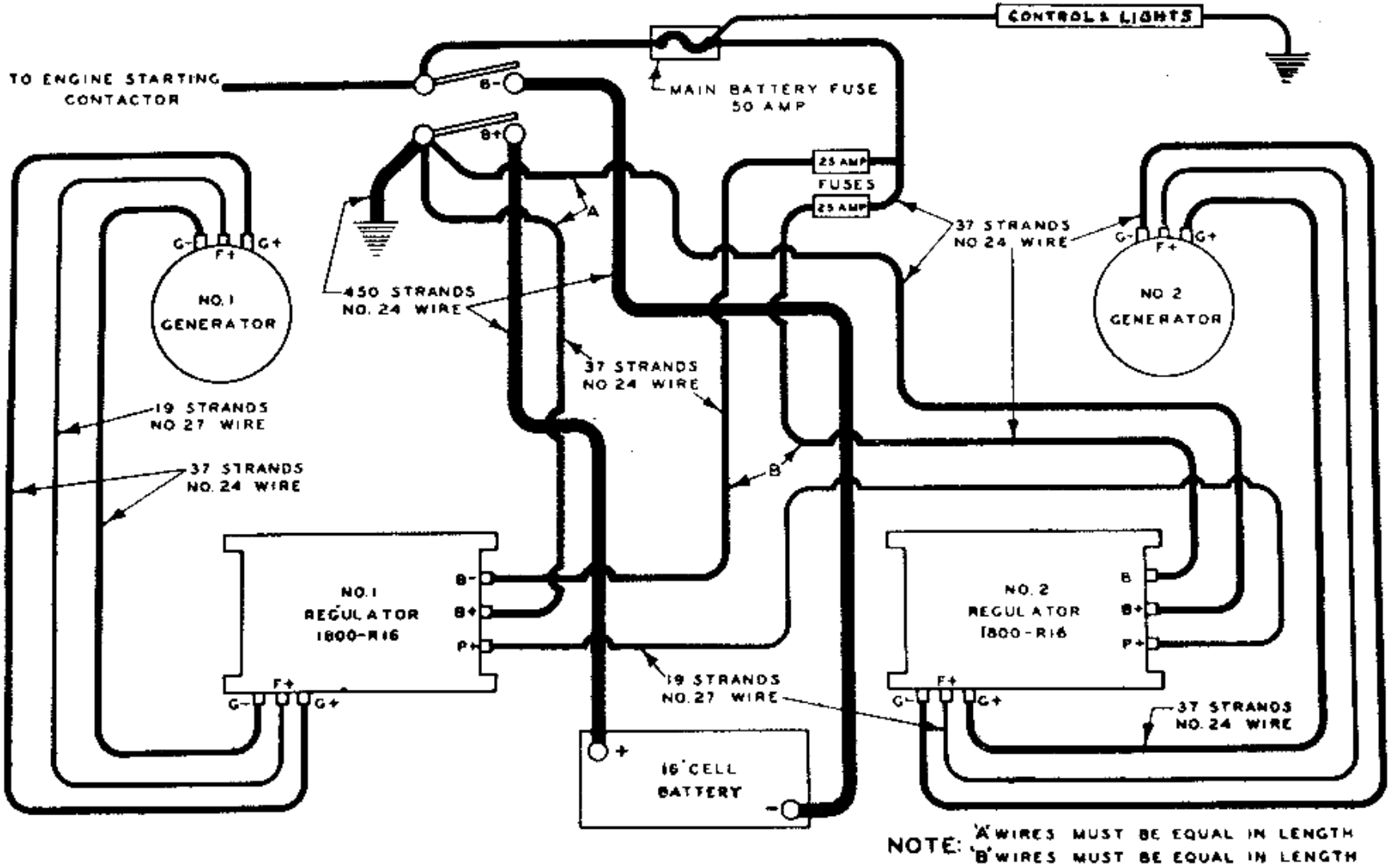


Figure 31. Regulator connection diagram.

If the contacts are spotted, clean with an aloxite block 150 or 180 grit. Place the block between the contacts and, with a slight thumb pressure on the armature, move the block back and forth slowly until clean.

g. Blow out all filings.

h. Be sure to reconnect the parallel line after checking.

113. Characteristics

The regulator or control unit (fig. 32) limits the output of the generator so that the charging rate within the capacity of the generator varies according to the load imposed by the electrical system and the condition of the battery. It consists of the following parts:

a. The cutout relay functions only when the generator voltage is sufficient to charge the battery. Below this predetermined value, the contacts remain open, preventing the battery from discharging into the generator.

b. The voltage regulator automatically limits the voltage from rising beyond the level for which it is set, thereby keeping the generator from charging at a higher point than is safe for the system.

c. The load limiter effectively controls the amperage or current output of the generator. As current is consumed, or if the battery is discharged, the load limitor varies the charging rate within the limits of the generator. The armature of the load limitor vibrates to introduce a controlling resistance which limits the charging rate of the generator to its designed capacity. The ampere output of the generator, within the designed limits, is controlled by the load limitor and no attempt should be made to change it by adjusting the cutout or voltage regulator.

d. The resistance units R6 and R7 (fig. 32) are for control in the voltage regulator circuit. The filter unit F-1 prevents arcing between the voltage regulator contacts.

114. Adjustment Instructions

a. It is advisable to check adjustments frequently at first, then regular periods of inspection may be established as conditions require (par. 112).

b. Due to operating conditions on the locomotive, it is not always practical to make adjustments to the regulator while installed on the locomotive. Consequently, in some instances, it will be necessary

to remove the generator and control equipment to a test stand, or provide a small variable speed engine or motor to drive the generator.

c. When the equipment is adjusted in the locomotive, the units should be connected according to the diagram shown in figure 32. If adjustments are made on a test bench, connections should be made as shown in figure 33. For parallel connections (the use of two regulators and two generators) refer to figure 31.

d. When the equipment is adjusted on the locomotive, care must be taken that the engine idling speed is adjusted to 550 rpm for the Cummins HBI engine, and 500 rpm for the HBIS engine. Due to the fact that the engines are governed at 1800 rpm, and different generator to engine speed ratios are used on the standard and supercharged engines, care must be taken to obtain the generator speed shown in the adjustment specification.

e. Make temporary adjustments at first so that no damage will result. Then operate the units for 15 minutes or more to heat them up and make the final adjustments. Do not close the cutout relay contacts at any time by hand. If Generators and Regulators are connected in parallel, adjustments are to be made on one unit at a time. The opposite set must be at rest. Detailed adjustment instructions follow. Refer to figure 32.

115. Adjustments

a. Cutout Relay.

(1) Disconnect the battery wire from the terminal (B-).

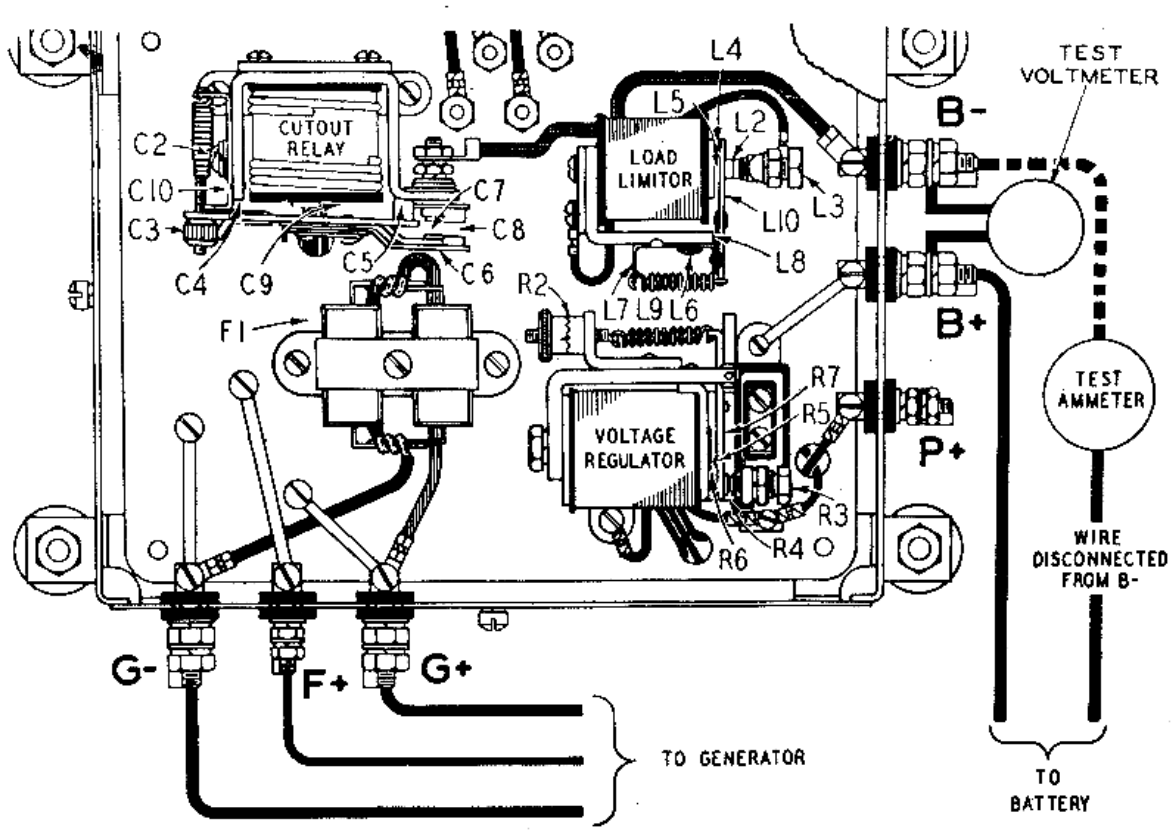
(2) Set the contact gap (C7) at .070 to .075 inch by bending the armature stop (C5). (Set when contacts are open.)

(3) Set the contact gap (CS) at .040 to .045 inch by bending the thin carrier (C6). (Set when contacts are open.)

(4) Loosen the two screws (C2) and move the bracket (C10) in order to set the hinge gap (C4) at approximately .005 to .015 inch.

(5) Set when contacts are closed.) (5) Set the gap (C9) between the armature and the core at .022 to .025 inch by adjusting the hinge gap (C4). (Set when contacts are closed.)

(6) The contacts at (C7) and (C8) should close when the voltage measured across the terminal (G-) and (G+) is from 28 to 29 volts. In addition to closing



B+	TERMINAL	F1	FILTER UNIT	P+	TERMINAL	TCSCO 21350	
B -	TERMINAL	F+	TERMINAL	R7	RESISTANCE		
C7	CONTACT GAP	G-	TERMINAL	L6	SCREW		
C8	CONTACT GAP	G+	TERMINAL	L7	BRACKET END		
C5	ARMATURE STOP	C3	ADJUSTING NUT	R4	CONTACT GAP		
C6	CARRIER	L2	CONTACT GAP	R3	SCREW		
C2	SCREW	L3	SCREW	R6	CONTACT GAP		
C10	BRACKET	L5	CONTACT GAP	R5	STOP PIN		
C4	HINGE GAP	L4	STOP PIN	R2	ADJUSTING NUT		
C9	CONTACT GAP	L8	HINGE GAP				

Figure 32. Regulator test connection diagram.

at 28 to 29 volts, both contacts must seal tightly when the generator armature speed is between 700 and 750 rpm.

Note. Turn the adjusting nut (C3) clockwise to increase and counter-clockwise to decrease the voltage until the proper adjustment is reached.

(7) Connect one lead of the ammeter to the negative (-) battery wire and the other lead to the (B-) terminal. From a generator speed at which the contacts at (C7) and (C8) are closed, decrease the speed to a complete stop. The contacts should open when the discharge current in the line is from 0 to 10 amperes. If necessary, readjust the nut (C3) to obtain this value and recheck the contact closing voltage.

b. Voltage Regulator.

(1) Set the voltage regulator contact gap (R4) at .045 to .051 inch by holding the contact open and turning the screw (R3). (Set when contacts are open.)

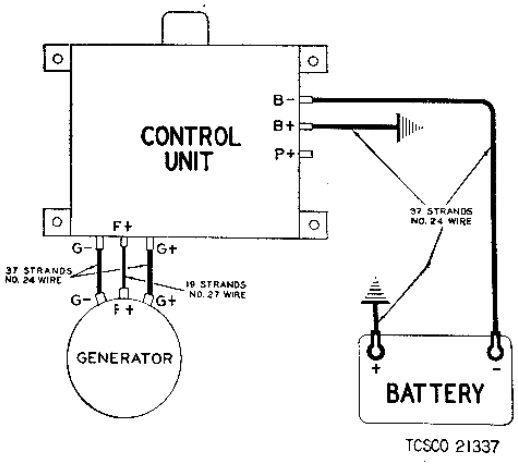


Figure 33. Basic connection diagram.

(2) Set the gap (R6) between the armature and the core at .060 to .065 inch. File the armature stop pin (R5) if necessary. (Set when contacts are open.)

(3) Disconnect the battery from the terminal (B-).

(4) With the generator running in the proper direction at a speed of 2500 rpm, the voltage across (B-) and (B+) should be from 37.5 to 38.0 volts. If it is not, turn the adjusting nut (R2) until this is obtained. Make a final check by increasing the generator speed from 0 to 2500 rpm.

c. Load Limitor.

(1) Set the contact gap (L2) at .025 to .030 inch by holding the contact open and turning the screw (L3). (Set when contacts are open.)

(2) Set the gap (L5) between the armature and the core at .015 to .020 inch by filing the armature stop pin (L4), if necessary. (Set when contacts are open.)

(3) Set the hinge gap (L8) at approximately .005 to .010 inch by loosening the screw (L6) and moving the bracket. (Set when contacts are open.)

(4) With the battery connected, run the generator at 2000 rpm using a lamp or a resistance load of 20 amperes on the generator. The ammeter in the line from the generator to the terminal (B-) should read between 20 and 21 amperes. If it is lower than 20 amperes or higher than 21 amperes, bend the bracket end (L7) to increase or decrease the spring pressure. (5) Recheck and readjust the voltage regulator element, if the adjustment has changed.

Section X. BATTERY INSTRUCTIONS

116. Charging-Regulator Settings

a. Keep the voltage regulator in adjustment in order to maintain battery fully charged as shown by a hydrometer reading.

b. The voltage regulator setting to use depends somewhat upon the number of hours per day that the locomotive is in service. However, for 8 to 12 hours' daily service, set regulator at 38 volts open circuit for the 16-cell battery as a trial start.

c. The voltage regulator setting may have to be changed for local conditions. Any adjustments should be made in small steps, one-half volt at a time. Use an accurate voltmeter. Follow the instructions furnished with the locomotive in making adjustments and adjust with the regulator on open circuit and with its coil hot.

d. The voltage setting should be decreased if the battery specific gravity is found at the full charge value and with the electrolyte temperature more than 15° F. above the outside air, or if the amount of water required is more than shown in paragraph 118.

f. The voltage setting should be increased if the battery specific gravity drops off from day to day.

117. Readings and Records

a. Daily.

(1) Take hydrometer reading, electrolyte temperature, and level of pilot cell at end of a working period. Every month, use a different cell as a pilot.

(2) Daily readings are desirable when the equipment is new, or after repairs, or after changes are made in the voltage regulator setting. When five daily readings show no adjustment needed, the pilot cell reading may be taken weekly.

b. Monthly.

(1) Record hydrometer reading of every cell. Compare these with previous readings to detect any irregular readings.

(2) Check and record setting of voltage regulator.

(3) Record amount of water added from time to time.

(4) Keep the records in a log book for reference by the supervisor.

118. Adding Water

a. Add approved or distilled water to each cell. The high point is one-sixteenth inch below bottom of filling tube (or nine-sixteenths inch above top of separators). Add before level lowers to top of separators.

b. Sufficient watering space has been provided so that with normal conditions water is required only once a month. However, check level each week.

c. All cells should take the same amount of water. If one takes more than the others, examine it for leakage.

d. If more than the maximum amount of water is required, unnecessary overcharging is indicated and the voltage regulator setting should be checked. If the minimum is not used for a battery in average service, undercharging is expected.

	Water additions per month	
Size of Battery	*Minimum*	*Maximum*
16 cells-LX-19G	1 ½ qts	2 ½ qts.
16 cells-LX-21G	1 ¾qts	3 qts.

119. Keeping Battery Clean

a. Keep vent plugs tight and in place at all times. Once a month, blow dirt off cell covers, trays, and out of compartment with moderate air pressure.

b. An accumulation of acid-soaked dirt on top of the cells and in compartment causes grounds, shorts, and corrosion. If cell covers are damp with electrolyte, wash them with bicarbonate of soda solution (1 pound soda to 1 gallon of water), rinse off with water, and blow moisture off cell covers and out of compartment with moderate air pressure.

c. Keep connections clean and tight.

120. Specific Gravity-Hydrometer Readings

a. The specific gravity or hydrometer reading of the battery is an indication of the state of charge. The specific gravity reaches a maximum when the battery is fully charged, but this maximum value varies somewhat with the temperature and height of the electrolyte.

b. With the electrolyte level one-sixteenth inch below bottom of filling tube, the full charge specific gravity at different temperatures is as follows:

77° F	1.270	1.285
107° F	1.260	1.275
47° F	1.280	1.295
17° F	1.290	1.305

c. With the electrolyte level at a lower point, the specific gravity for each temperature would be a few points higher.

d. A specific gravity about 75 points below values given above (1.200 at 77° F.) would indicate a battery approximately one-half charged.

121. Important Points

a. Do not work on battery or in battery compartment without first opening the main battery switch.

b. Keep all flames away from the battery. c. Do not lay any tools on top of cells.

d. Low electrolyte temperatures temporarily reduce the battery capacity.

e. Continued and frequent temperatures above 115° F. shorten the life of the battery. Provide full ventilation in warm weather.

f. With proper operation, the battery temperature should not be more than 15° F. higher than the temperature of the outside air

Section XI. KEROSENE BURNING WATER HEATERS

122. How to Set Wick

Before operating the water heater, see that the wick is properly set in the following manner (fig. 34).

a. Remove the drum (A) so the wick can be seen clearly.

b. Turn hand wheel (G) until the indicating pointer (H) is at the hole in the dial.

c. With the thumb of the right hand, press the pointer through the hole as shown in figure 35. Hold it there.

d. With the left hand, turn the hand wheel, raising or lowering the wick until the wick top is one-sixteenth inch above the top of the wick tubes. Then release pointer. The wick is now properly adjusted.

e. It is occasionally necessary to reset the wick as it burns down in order to restore high flame and get the fullest possible use out of each wick.

123. Fuel

Use only a good grade of kerosene. Never use gasoline or mixtures containing gasoline.

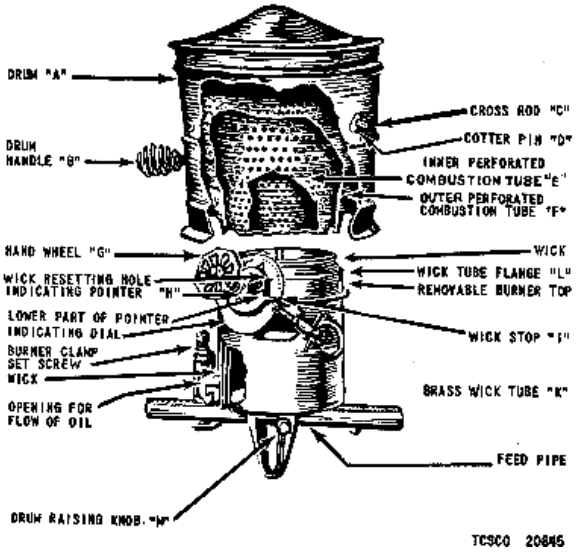


Figure 34. Cross section of kerosene burner.

124. How to Light

Fill the oil reservoir and see that all parts of the burner are in place as shown in figure 34, with the drum (A) in raised position. Drum is raised by means of a small handle (M) in the slot below the feed pipe. Turn the hand wheel to the right until indicator pointer rests against wick stop. Light the wick in several places, then lower drum gently in place by lowering handle (M) in the slot. Turn drum to the right and left by means of handle (B) to make sure that it rests evenly on the wick tube flange (L). Three to five minutes are required for the flame to reach its fullest height. The high flame should be clear blue in color, but when burner has been operating at low and is turned to high it will burn yellow for a short time.

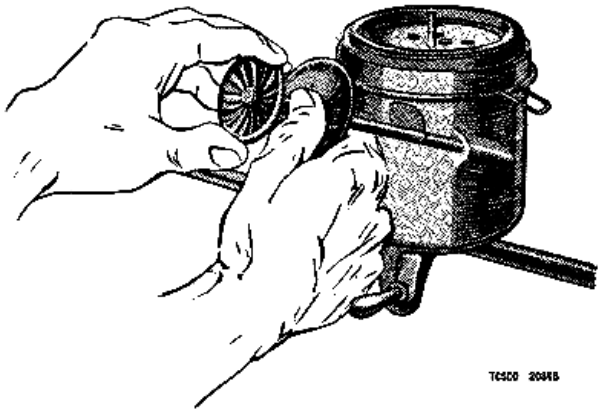


Figure 85. Wick setting.

125. How to Extinguish

a. Turn hand wheel to left as far as it will go. *b.* When the flame has gone out, raise the drum by means of lifter handle (M) leaving it in the raised position as shown in figure 34. Leaving the drum in a raised position prevents oil from creeping up on
b. the combustion tube which would cause an odor when the burner is again lighted.

126. Care of Wicks and Burners

At least once every other day, the brass wick tube should be thoroughly cleaned.

127. Cleaning Wick

a. First remove burner drum, then raise the wick even with the top of the tubes. Scrape all carbon crust from the top of the wick with the edge of the cleaning tool furnished with the stove. Do not try to clean the wick too thoroughly as this unnecessarily wastes it. A certain amount of char on the edge of the wick gives a perfect flame. Now turn the wick down into the wick tube as far as it will go. Remove the screw top by taking hold of the wire handles and turning a quarter turn to the left (fig. 36). Scrape inside and outside of the screw top thoroughly, being careful to remove all dirt and carbon from the flange (L, fig. 34) on which the drum and combustion tube rest. Brush all loose particles of carbon or scale from the wick tubes and flange. Then wipe with a dry cloth and replace burner top and drum. See that holes in combustion tubes are clean and open.

b. When the burners are in long continuous use, it is necessary, after 10 or 12 hours of steady burning, to turn the wick up and down in order to loosen and break away

carbon at the top of the wick tubes. Otherwise this carbon will seal the wick tightly at the top of the tubes and some of the wick may he broken away, resulting in an unsatisfactory flame.

Figure 36. Dismantling burner for cleaning.

128. Correcting Sticking Wicks

When wick tubes become *covered* with gummy oil. causing the wick to work hard and keeping the drum from seating properly, they should be cleaned in the following manner: Remove oil reservoir and drain feed line. Loosen burner clamp set-screw. Remove wick tube from feed pipe, unscrew top, and take wick out. Place the wick tubes in pan of boiling water deep enough to cover them. Add about one-half pound washing soda or any good cleaning compound. Do not use lye as it will damage the brass tube and do not boil in aluminum vessels as soda dissolves aluminum. Boil for 1 hour, then all gummy substances will either be boiled off tubes or so thoroughly loosened that it can be easily scraped away. Clean out the feed pile by twisting a wire through it to loosen all sediment, then rinse with clean oil. Take the wick tubes from boiling water, turn upside down to drain, then replace on feed pipe taking care that the hook is placed under the feed pipe and that the setscrew is tightened firmly without forcing. Replace feed pipe, cap, wicks, and reservoir. After resetting wicks, the burner will be ready for operation. If the burners are occasionally cleaned in this way, they will operate in a satisfactory manner indefinitely.

129. Re-Wick Burner

The wick supplied with the burner is of the proper type. It is essential that the same type of wick or equal be used when making replacement. Substitute wicks cause trouble. The wicks come attached to metal carriers ready for inserting. They are burned at the factory to proper burning; edge.

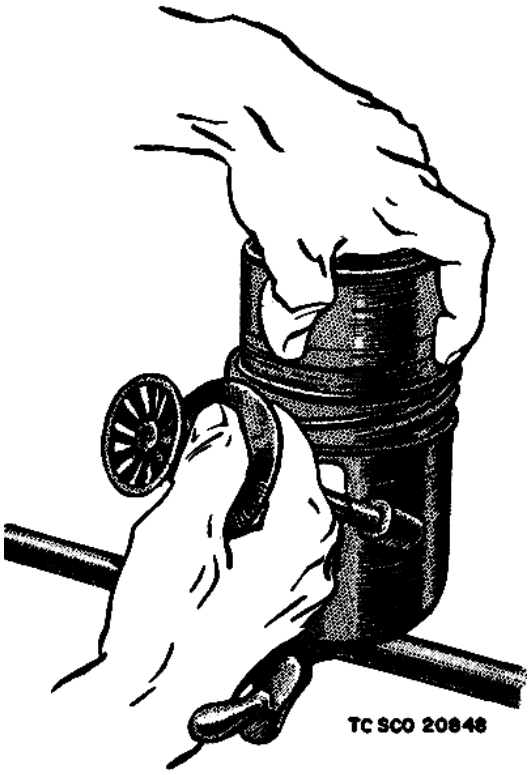


Figure 3!. Rewick wick burner.

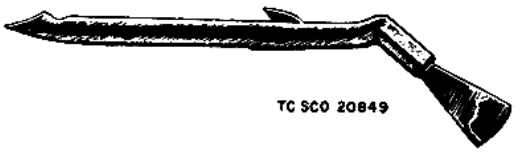


Figure 38. *Burner cleaning tool.*

ready for use. They should not be mistaken for used wicks. Remove the drum and press the indicating pointer through the hole in the dial (fig. 35) ; while holding it there, turn hand wheel to the right until the wick carrier is lifted as high as it can go. Lift out the old wick and insert the new. Press the wick downward until the carrier engages with the teeth on the lower end of the hand wheel spindle (fig. 37). Turn the wick down until top edge is one-sixteenth inch above the wick tube, then release indicator pointer.

130. Cleaning Water Heater Units

Operating the heater with too high a flame will cause the heating units to be covered with smoke and soot. This results in a great reduction in efficiency. The heating units as well as the burner parts should be cleaned thoroughly and all soot removed. The heater casing can be easily raised for cleaning or inspecting. When cleaning the heating units, be sure to cover the burner to protect it from falling soot.

131. Care of Heater When Not In Use

When the water heater is not to be used for several months, it should be carefully drained to prevent freezing and rusting. After shutting off the water, open drain faucet at bottom of tank and thoroughly drain the system. To make sure that no water remains in the heating unit, unscrew the pipe connections at the lower part of the heater. Unscrew the cap at end of oil feed line and drain. Should heater not produce hot water satisfactory, examine all piping to see that it is arranged as shown in how to install directions.

Caution: Do not place combustible material on parts of heater, or permit such material to accumulate around heater.

Section XII. TRUCKS AND RUNNING GEAR

132. Description

There are two swivel type equalized trucks of two axles each. Each truck has a center plate which supports the superstructure and allows the truck to swivel freely on the curves.

133. Repairs Without Removing Truck

The following parts on the truck or frame structure, listed in paragraphs 134 through 142, can be serviced without removing the trucks or wheel and axle assemblies.

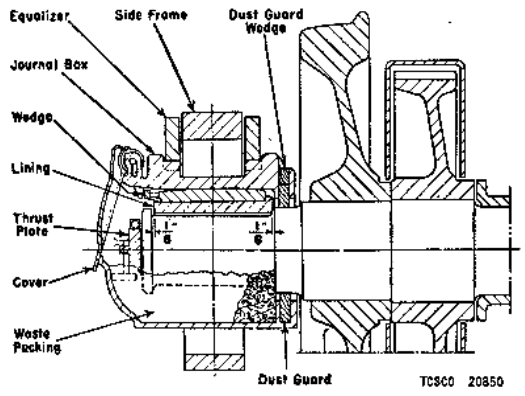


Figure 39. Plain bearing journal box, sectional view.

134. Journal Boxes

a. General. The bearings in these boxes are plain bearings as shown on figure 39. The cover on the front of each box is hinged at the top and is held down tightly by a spring. A fiber dust guard and wedge fit into the slot on the back of the box and prevent dust from entering and oil from seeping out around the axle.

b. Waste.

(1) During operation, the waste may sag somewhat, thereby impairing its lubricating qualities. Its effectiveness can generally be renewed without adding additional waste by loosening with a packing iron.

(2) Glazed waste next to the journal may cause overheating even with sufficient oil in the box. When this condition is found, remove the waste except the roll at back of the box. If the roll is in good condition, do not remove it, but repack the rest of the bottom of the box. All except the glazed portion of the waste removed may be used again.

e. Wear Limits.

(1) This locomotive is fitted with collar type journals for taking end thrusts of the axle.

(2) Bearings may continue in service as long as they give satisfactory operation, even though they may have worn through the babbit lining.

(3) When new, the end thrust is approximately 1/8 inch on a side and is taken entirely on the journal bearing shoulders. Renewal of the bearing is not necessary until clearance is approximately one-half inch on a side.

d. Removal of Bearings. Place a jack under the journal box and lift it high enough that the lug on the top side of the box will clear the wedge. Remove wedge and bearing.

135. Pedestal And Journal Box Wear Plates

a. Description. The journal boxes and pedestals on the truck frames have hardened high carbon steel (SAE 1045) wear plates which can be renewed to compensate for wear in the pedestal guides. These wear plates are tack welded into place.

b. Clearances and Limits of Wear. Reduce clearances to approximately one-sixteenth inch per side or one-eighth inch total movement by renewing wear plates. Greater wear may be permitted if the operation is not objectionable.

c. Patching Cracked Welds. If a weld on a journal box or pedestal wear plate is cracked, it may be "patched" by welding with a stainless steel (18-8) welding roil. Preheating to over 15W C.. *will* result in a better weld.

d. Renewal of Near Plates.

(1) Badly worn wear plates on journal boxes and pedestals can be renewed without removing the wheel and axle assembly. Better fitting and welding of wear plates can be done, however, if the wheel and axle assembly is removed, thus allowing wear plates to be clamped tightly into place.

(2) To renew wear plates with wheel and axle assembly in place, proceed as follows: Remove pedestal tic bar. Chip weld from wear plate and drive wear plate out through bottom of opening. Push new wear plate into position and wedge securely so that wear plate makes good contact with the part it is to be welded on to. Preheat parts to 150° C. Apply weld uniformly. Replace pedestal tic bar.

136. Hand Brakes

a. Description. The hand brake has a pawl and ratchet which latch the brake shaft and hold the brakes in applied positions. A chain and lever
arrangement connected to the hand brake shaft operates the power brake rigging and applies the brakes.

b. Renewal of Chain. Release hand brake. Disconnect chain by removing pins or bolts that secure it to hand brake. On pulley types of rigging, the chain must be passed over the pulleys smoothly without any twists which may cause binding.

137. Brake Rigging

a. Description. The brake rigging consists principally of a system of rods and levers which transmit the force from the brake cylinder or cylinders to the brake shoes.

b. Brake-Shoe Adjustment. As brake shoes wear, the brake-cylinder piston travel will increase. Piston travel should not be permitted to exceed 5 inches. To adjust brake rigging to compensate for shoe wear, proceed as follows:

(1) Loosen lock nuts (fig. 401.

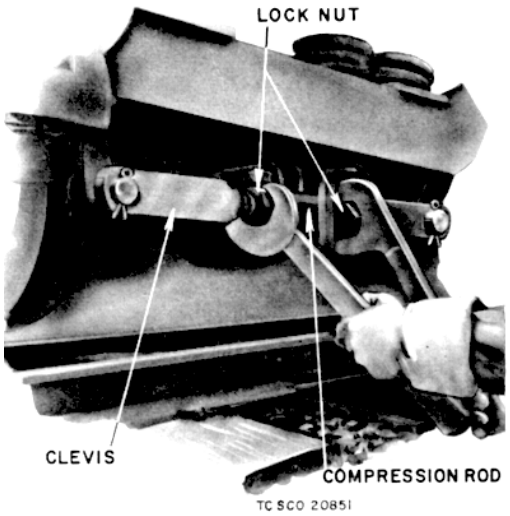


Figure 40. Adjusting brake shoe travel.

(2) Turn compression rod in clevises until shoes clear tread of wheel by one-fourth inch. Compression rod has right and left hand threads; hence it operates like a turnbuckle.

(3) Tighten lock nuts.

(4) Apply brakes. Check piston travel (2 ½, inch minimum. 5-inch maximum).

(5) Release brakes. See that shoes clear wheel treads.

c. Brake Shoes. These shoes are of the flanged type and have a recess or skid retarding groove which fits the flange of the wheel and holds the shoe in proper position against the wheel tread.

d. Renewal o f Shoes.

(1) Disconnect compression rod.

(2)Remove brake-shoe stabilizing device.

(3) Remove brake-shoe key by pounding on lug of key to force it out of shoe and shoe head; shoe should now drop off of brake head.

(4) Fit new brake shoe onto shoe head and line up key slots in shoe with slots in shoe head.

(5) Remove irregularities from contour of key. Key should follow contour of shoe evenly so that it will engage slots of shoe and shoe head. Place shoe on shoe head and line up key slots; then drive key into place.

(6) Connect rod.

e. *Brake-Shoe Stabilizing Devices.* These devices consist of a spring and pin arrangement mounted on the brake-shoe head and lever and insuring uniform contact between the shoe and the wheel. The pins and springs should be tightened to the point where there is a fair amount of rigidity and still allow the flexibility necessary for uniform contact between shoe and wheel tread.

138. Couplers and Draft Gear

a. Description. An arrangement of the pockettype coupler is used on these locomotives. The pocket is bolted to the end frame of the locomotive cab platform. Some coupler pockets are provided with oblong holes in the four corners of the pocket for bolting to the underframe. Spacer washers with a hole near one end permit raising the height of the coupler and pocket. It is not necessary to make any adjustment for height while in service because the locomotives leave the factory near the upper limit of $34^1/2$ inches from the top of the rail to the center of the coupler knuckle. Wear in wheels and other wear causes the height to decrease. ICC standards for freight cars are $34^1/2$ inches for the upper limit and $31^1/2$ inches for the lower limit, which is the rule that is applied also to locomotives meeting ICC requirements. Where ICC requirements do not have to be met, a somewhat greater range may be used.

b. Lost Motion and Wear Limits. The amount of end play between the end of the guard arm and the face of back stop is known as lost motion. On locomotives operating under ICC requirements, the lost motion in draft gear must not exceed one-half inch, otherwise somewhat greater wear may be permitted.

c. Disassembly. Remove couplers simply by removing the bolts and bushings on the end frame mounting. The friction draft gear is removed as a complete unit by removing the bolts from the draftgear keys and pulling them downward and out of the bottom of the draft-gear housing in the end frame. The buffer block on the end frame must be removed by removing the bolts that secure it to the end frame. The draft gear can then be withdrawn from the locomotive.

d. Reassembly.

(1) Install the couplers by bolting them on the end frame. Elongated slots and bushings through which the mounting bolts are secured provide adjustment for height.

(2) Install friction-type draft gear by placing it in the draft gear housing and installing the keys through the openings under the bottom plate of the housing and bolting them into place. The buffer block is then mounted over the draft gear and bolted onto the end frame.

139. Side Bearings

a. Description. Side bearings are used on swivel truck locomotives between the cab underframe and the trucks to limit the tilt of the cab with respect to the trucks. This locomotive has renewable wear plates of high-carbon steel (SAE 1045) on the underside of the platform only, as rollers are mounted on the top of the truck bolsters. (fig. 41.)

b. Inspection and Maintenance. Locomotives in interstate commerce must meet the requirements of the ICC for side-bearing clearance. This rule states that the maximum clearance of side bearings will not exceed one-fourth inch on each side, or a total of one-half inch on both sides where the spread of the side bearings is 50 inches or less. Where the spread is greater, the side bearing clearance may be increased in proportion. This rule should be followed even though locomotives are not governed by the ICC. When the clearance is excessive, the worn wear plates must be removed and replaced by new ones.

e. Removal and Renewal o f Side Bearings. Remove the base and roller by removing the two bolts that secure it to the top of the truck bearing support. The wear plates on these side bearings can be renewed by chipping off the worn plate and welding a new one into place. Use stainless steel (18-8) welding rod and preheat parts to 150° C. Renew the lower bearing, when excessively worn with a new roller and base.

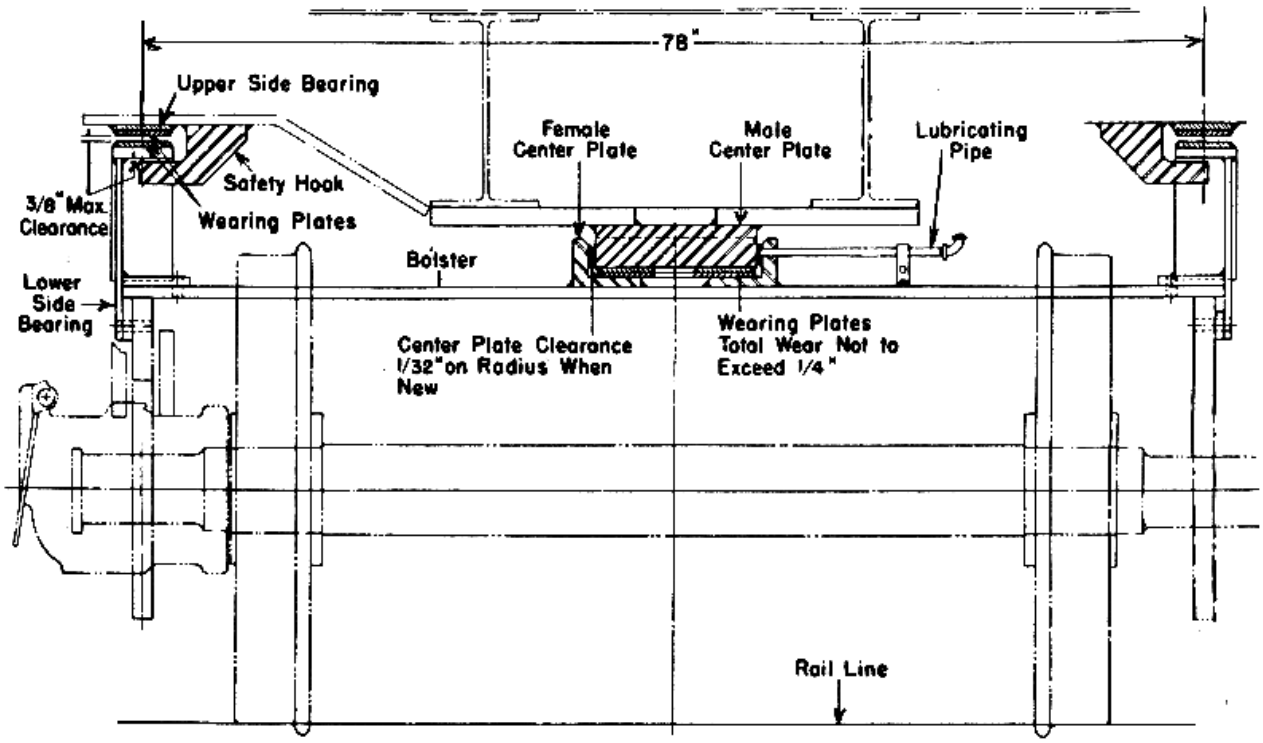


Figure 41. Typical center and side bearings, sectional view.

140. Anti-Slewing Device

a. Description. Locomotives with swivel trucks have an anti-Slewing device to limit the swiveling of the trucks. They serve as a protection and warning if the locomotive is derailed or a sharper curve is encountered than for which the locomotive is designed.

b. Instruction and Maintenance. Anti-Slewing devices require very little attention under normal operating conditions. Inspection should be made in case of derailment to determine if lugs are cracked or bent and if mounting bolts are tight.

141. Springs And Equalizers

a. Description. The springs transmit the load from the truck frame to the equalizers. The ends of the equalizers transmit the load to the top of the journal box. There are two equalizers on each side of the truck straddling the truck side frame. One spring in each group is a combination snubber spring, there being four such snubber springs per truck. The snubber springs reduce rebound by consuming some of the energy stored in the spring during compression.

b. Renewal of Springs.

(1) Disconnect compression rods. Jack up the side frame high enough to release the load on the spring with enough added movement to allow a clearance for the spring to be removed.

(2) Place new springs on spring seats and lower side frame slowly into position. Connect compression rods.

142. Motor Suspension

a. Description.

(1) About one-half of the motor weight is carried directly by its axle. The other half of the motor weight is carried by an extension on the motor called the motor nose which is mounted on an extension from the truck frame.

(2) The motor nose suspension consists of four springs with a bar and wear plate on top and bottom. These wear plates are made from SAE 1045 steel and have good wearing qualities (fig. 42).

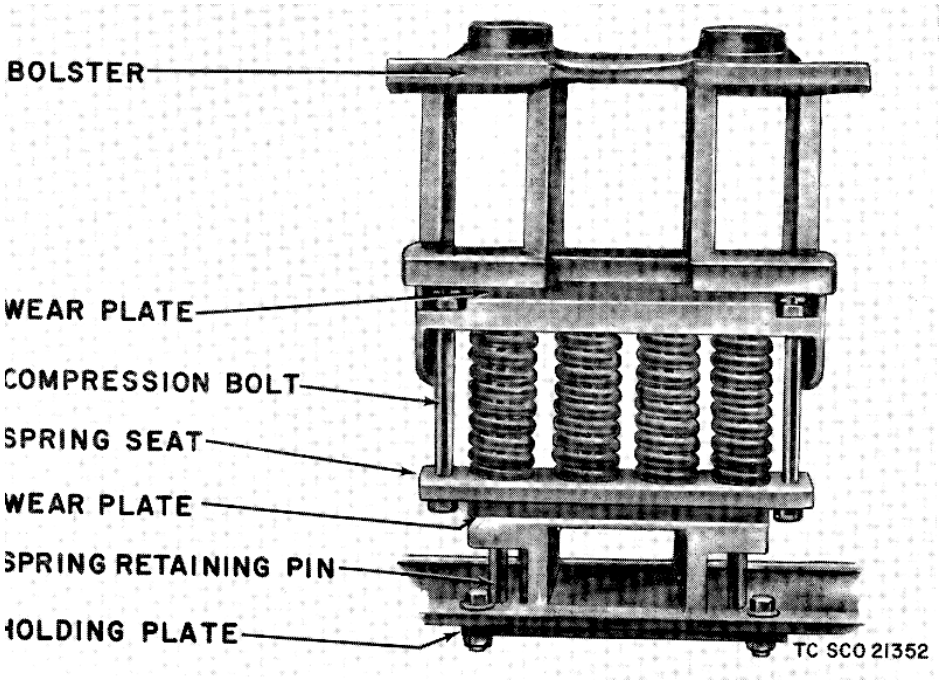


Figure 42. Motor suspension.

b. Removal. Tighten the bolts in the ends of the spring nest. If no bolts are present, obtain suitable bolts and insert in slots. Remove the holding plate under the nose suspension and drop the pins out. With a jack or overhead crane, lift the motor just enough to take the load off of the suspension. Slide suspension out to one side.

c. Installation. Aline jaws of motor nose with suspension mounting of truck. Compress springs by tightening bolts. Slide motor suspension into place. Install pins and mounting plate. Lower motor into place.

d. Renewal of Springs and Wear Plates.

(1) Remove the motor suspension from the truck. Remove the bolts on the end of the spring plates. Remove defective spring and install new one. Replace bolts and tighten them to compress springs so that assembly can be placed in truck.

(2) To renew wear plates, disassemble spring nest as explained above. Remove worn wear plates by chipping off welds. Preheat wear plate and spring plate to 150° C., and tack into place, using six evenly spaced -inch by 1-inch welds. Use stainless steel (18-8) welding rod.

143. Repairs Requiring Truck Removal

a. Some parts of the running gear and trucks cannot be serviced unless the trucks or running gear are removed from the locomotive. An overhead crane and a drop pit greatly facilitate service operations on trucks and running gear.

b. Where an overhead crane is available, the cab platform may be lifted with cables. Some locomotives have a hole at the end of each platform bolster through which a lifting eye can be inserted for this purpose. This hole is covered with a cap and bolt which must be removed. Other locomotives have lifting lugs at the platform bolsters around which the cables can be looped.

c. Safety lugs on locomotives with side bearings are strong enough so that the trucks may be lifted with the cab. Some locomotives do not have these safety lugs. Use jacks if no overhead crane is available. Do not place jacks under any part of the cab structure that will be damaged. A support is provided at the end of each platform bolster for this purpose. It is also permissible to jack under the center of the cab-frame end plate, below the coupler. In jacking one end of the locomotive at a time, care should be taken that no interference takes place on the end not being raised.

144. Trucks

a. Removal. To remove swivel-type trucks from locomotive with Jacks

(1) Remove the end steps from both ends of the locomotive.

(2) Remove the side steps if these interfere with placing the jacks or with any parts of the truck as it is rolled away from under the cab platform.

(3) Remove the side bearings when safety lugs are used and remove safety chains and the center bearing safety pins when used.

(4) Disconnect the air hose between the truck and the cab, also the hand brake chain, when brake cylinders are mounted on the truck. Disconnect the brake levers leading to the truck if brake cylinder is mounted under cab platform.

(5) Disconnect motor leads and mark them if they are not already marked, to assure getting them reconnected properly.

(6) Disconnect sander hose between platform and truck and remove sand traps from platform.

(7) Block wheels on the end not being raised. This will prevent the truck from rolling on the track. A heavy chain placed across the rails behind the wheels makes a good wheel block.

(8) Place jacks under the ends of platform bolster. Parts of the truck may interfere with the jacks as the truck is rolled out. Should these conditions be encountered, it will be necessary to jack up the cab a sufficient distance and set it on blocks, and relocate the jacks under the ends of beams or rails placed across the bottom of the locomotive. Place the jacks far enough from the truck to allow clearance. Place beams or rails so that the center sill or the bolster plate of the cab platform rests on them. Place blocks under the beams to shore and stabilize the cab platform. Do not allow the weight of the platform to rest on the side channels.

(a) If the jacks do not have sufficient lifting range to raise the cab platform high enough to remove the truck, it will be necessary to rest the cab platform on blocks and relocate the jacks and set up higher for another lift.

(b) Do not lift the entire cab at once by means of ordinary jacks because of the comparative instability of such jacks with the consequent danger of accidents. However, it should be entirely safe if special jacks with wide bases are used. There is no special advantage of raising both ends of the cab platform, even when both trucks are to be removed, as one truck at a time can be taken out by the use of only two jacks.

(c) There is sufficient clearance in the center bearings to permit leaving one end of the cab resting on its center plate, while the other end is raised high enough to permit truck parts to clear coupler housing and end frame. Do not raise the cab platform any higher than necessary to clear, as binding will take place. (d) To remove the cab platform from the trucks when an overhead crane of sufficient capacity is available, it is necessary to perform only the operations under steps (3)to (6) inclusive, above, and then lift the cab.

b. Installation. To install swivel type trucks with jacks

(1) Raise cab platform and block into position as described in removal procedure.

(2) Place truck on track and push it under platform to a position where center plate on bottom of platform will engage center plate on top of truck.

(3) Apply car journal oil to both center plates.

(4) Lower cab platform slowly into position. Watch center plates closely and do not permit binding to take place.

(5) Remove all blocking except wheel blocks.

(6) Connect motor leads and wrap them with tape.

(7) Install sand traps and connect sander hose between cab platform and truck.

(8) Connect air hose between cab platform and truck.

(9) Connect hand brake chain and brake rigging.

Note. On locomotives with brake cylinder mounted under cab platform, install the brake rods and levers between platform and truck.

(10) Install side bearings or the center-bearing safety pins and safety chains.

(11) Install side steps and end steps.

(12) Remove wheel blocks.

145. Center Plates

a. Description.

(1) Locomotives with swivel trucks have center bearings each consisting of a male and female center plate. These support the cab platform and allow the trucks to swivel freely on curves.

(2) The male center plate is mounted on the cab bolster on the bottom of the cab platform. The female centerplate is located on the top of the truck bolster. Wear plates of high-carbon steel (SAE-1045) are welded to these center plates. Under normal operating conditions, these wear plates should show few signs of wear and may continue in service until pounding and jarring are noticed in operation.

b. Renewal of Wear Plates.

(1) Chip off weld on worn wear plate.

(2) Remove wear plate.

(3) Grind center plate smooth, removing remains of weld and upset metal.

(4) Place wear plate on center plate and clamp it tightly in place.

(5) Preheat the wear plate and center plate to 150° C., and weld with stainless steel (18-8) welding rod.

(6) Apply four 3/16-inch by 4-inch welds uniformly and evenly spaced around the edge of the wear plate.

(7) Apply 8/3/16-inch weld to ends of wear plate.

(8) Grind welds, removing scale and excess weld.

146. Motor-Wheel-Axle Assemblies

Removal and disassembly from the trucks can best be accomplished by placing the truck over a drop pit. This will allow ample room for working and dripping the motors. Use the following procedure, even though a drop pit is not available.

a. Removal.

(1) Remove truck from under cab platform and block wheels.

(2) Remove waste and drain oil from motor axle bearings.

(3) Disconnect or remove parts that interfere with the removal of the wheel and axle assemblies, such as brake rigging, compression rods, safety straps, brake beams, and sander pipes.

(4) Tighten the bolts in the ends of the spring nests of the motor suspensions. If no bolts are present, obtain suitable bolts and insert them in slots.

(5) Pass a cable around the motor or through the lifting bails on the motor case and secure to an overhead crane or beams placed across the truck.

(6) Remove motor suspension. Refer to paragraph 142.

(7) Engage hoist on motor, remove cross beam, raise motor and swing it 180° from its original position, and lower it downward to roadbed level or into drop pit.

(8) Remove pedestal tie bars by removing the bolts that secure them to the bottom of the pedestals.

(9) Insert metal rods between equalizer bars and top of truck frame pedestals.

(10) Secure cables to truck frame and lift from journal boxes.

(11) Preserve wheel and axle assemblies that are to be stored in accordance with Specification MIL-P-3127.

(12) Remove journal boxes.

b. Assembly.

(1) Place wheel and axle assemblies on tracks

(2) Place axles on 80-inch centers.

(3) Install journal boxes and block them into an upright position.

(4) Be sure that metal rods are in place between equalizer bars and tops of truck frame pedestals to hold equalizer bars in place.

(5) Pass hoist cables under truck-frame. Lift truck-frame and move it directly over wheel and axle assemblies. Lower truck frame slowly, engaging truck-frame pedestal guides in journal box pedestal ways. Guide equalizer bars into place in equalizer bar seats on top of journal boxes. Lower truck frame until it rests on springs. Remove metal rods from in between equalizer bars and pedestal guides of truck frame.

(6) Install pedestal tie bars.

(7) Install motor suspensions and safety lugs.

(8) Pack waste and put oil in motor axle bearing.

(9) Install brake rigging, compression rod, levers, and brake beams.

(10) Install safety straps and sanders.

147. Motor Axle Mounting

The motor and gear case assembly is held on the axle by two friction bearings. These bearings must be removed before the motor can be lifted clear of the axle.

a. Removal.

(1) Remove truck from locomotive.

(2) Remove motor-wheel-axle assembly.

(3) Engage hoist on motor or block in level position.

(4) Remove gear case and dust guard. (5) Remove bearing caps.

(6) Remove outer bearings and wrap them in clean oiled paper.

Note. Inner bearing will usually remain in housing; care should be taken, however, that loose bearings do not drop out and become damaged.

b. Installation.

(1) Wipe bearings and housing clean.

(2) If inner bearing halves have been removed from housing, install them by pushing them into place against the key in the housing. Bearings should fit tight in the housing.

(3) Lower motor into place on axle and block it in a level position. Apply sealing grease to oil retaining grooves in gear box and cover before installing.

(4) Place outer halves of bearings into position on axle.

(5) Install bearing caps and place cotter pins in bolts.

(6) Wipe gear ease felts clean and apply light oil. Install gear case and dust guard.

148. Journal Boxes

a. Removal.

(1) Lift the box and remove the wedge and the bearing, then slide it off over the end of the axle.

(2) Engage a puller on the journal box and pull it off of the axle.

(3) Cover journal box and bearings to protect them against dirt or damage.

(4) The inner collar can be removed by holding a hot ring against it until it expands enough to be removed. Do not use a torch or flame for heating this collar.

b. Assembly to Axle.

(1) Heat collars and inner-bearing races in an oil bath to a temperature of not over 150° C.

(2) Remove inner collar from oil bath and quickly slide it into place on axle against shoulder.

(3) Slide one outer-bearing race into bore of box and push it tightly against shoulder in box.

(4) Lubricate bore of outer-bearing race with 1/4-inch layer of ball bearing grease.

(5) Slide journal box on over end of axle and into position against collar.

(6) Remove one inner-bearing race from oil bath and quickly slide it into place on the axle against the collar. Hold it there until it cools enough to be set firmly on axle.

(7) Apply a heavy coat of ball bearing grease to inner-bearing race.

(8) Grease bore of outer-bearing race and slide it into box.

(9) Bolt cover and shims onto box; draw up bolts tightly.

(10) If box binds and does not turn freely, remove cover and install another shim. If box is loose, remove a shim. The box should be adjusted to a condition where the addition of a 0.005-inch shim to a tight box will cause it to rotate freely. The boxes should be inspected after cooling to determine if they are still in adjustment.

149. Wheels

a. General.

(1) Wheels which are excessively worn or shelled should be removed from service. Multiple-wear rolled-steel wheels are used on these locomotives. The tread of the wheel as shown in figure 43 can be turned several times before it reaches a condemned condition. Do not attempt to patch cracks, shelled, or worn away treads by welding, as the carbon content of the steel is between 0.57 and 0.77 percent. Application of heat or welding on a wheel is a dangerous practice, and will inevitably result in a wheel failure. Restore wheel treads and flange contours by turning them in a large bull lathe.

(2) Wheels are stamped with identification numbers and letters on the inside face of the flange. The information given on the wheels is the date, manufacturer's name, serial number, heat number, carbon content and heat treatment, American Association of Railroads and wear class of wheel.

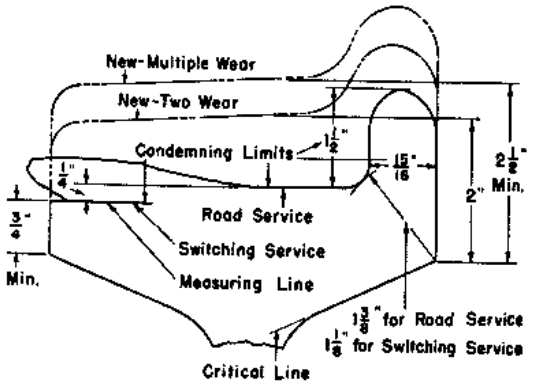


Figure 43. Wheel wear diagram, sectional view.

b. Removal of Wheels. Use a horizontal press of 200-ton capacity.

(1) Place wheel and axle assembly on movable blocks or supports, with the wheel to be removed on the ram end of the press. If the blocking or supports are mounted on rollers, it will allow the axle to move with the travel of the ram and it will not be necessary to change the setup as the axle is pressed from the wheel.

(2) Locate the axle in such a position that its center line is level and coincides with the center line of the thrust of the ram.

(3) Secure the pressing yoke or bars to the press on the flange side of the wheel so that they are at right angles to the line of thrust of the ram and will make uniform contact with the wheel.

(4) Cover the journal-bearing seats to prevent scoring.

(5) Support the wheel by a tong hook and hoist.

(6) Bring ram forward slowly until it contacts the end of the axle. Apply pressure gradually. After wheel is loosened and axle starts moving, less pressure will be required. Excessively high pressure and jolting ram action may cause metal pickup and damage to both the axle and wheel bore.

c. Mounting Wheels. Use a horizontal press having a maximum capacity of at least 150 tons. The press should have controls that regulate the rate travel and pressure delivered by the ram. The press must have a pressure gage which shows the resulting pressure in tons accurately. A graph attachment which records the pressure for length of ram travel is also desirable. The mounting pressure should be between 12 and 17 tons for each inch diameter of wheel seat on the axle.

(1) With a fine mill file or emery cloth, remove all nicks and sharp edges from wheel bore and wheel seat of axle. Inspect edge of wheel bore on inside hub face and outside edge of wheel seat; remove any burs or sharp edges. The edge of the wheel bore should have approximately 1/8-inch chamfer or radius to prevent gouging or cutting into wheel seat.

(2) Clean both wheel bore and axle, removing all dirt, abrasive material, and grease. Loose scale and dirt should be removed from the surface of the wheel to prevent it from falling on the wheel seat during the pressing operation.

(3) Check the wheel bore and the wheel seat with inside and outside micrometers to determine if there is adequate press-fit allowance. This should be 0.001 inch for each inch of wheel seat diameter.

(4) (4) Apply a smooth, even coat of pressing lubricant to both the wheel bore and wheel seat. A good pressing lubricant can be made by mixing 2 pounds of white lead with 1 quart of light lubricating oil to which a tablespoon of powdered graphite is added. This mixture must be stirred thoroughly and allowed to stand several hours. Keep mixture free of dirt and foreign materials, and stir before application to wheel seat and wheel bore.

(5) Protect bearing seats with a suitable covering of cloth and sheets of soft metal.

(6) Place wheel on axle (flange side in) and rest it on the edge of the wheel seat and a wooden wedge placed on the covering of the journal bearing.

(7) Place wheel and axle on movable blocks or supports in a horizontal press, with the wheel to be mounted on the opposite end of the ram. If the blocking is mounted on rollers, it will allow the axle to travel forward with the travel of the ram.

(8) Support wheel to be mounted with a tong hook or clamp on a hoist.

(9) Secure the pressing yoke or bars to the press on the rim side of the wheel so that they are at a right angle to the line of thrust of the ram and will make uniform contact with the wheel.

(10) Locate the axle in such a position that its center line is level and coincides with the center line of thrust of the ram.

(11) Use a square to properly aline the wheel with the wheel seat.

(12) Bring the rain forward slowly until it contacts the end of the axle, and gradually apply pressure. Do not allow wheel to become cocked or out of square with axle. Mount wheel slowly; do not attempt to speed up mounting, as metal pickup and tearing of both the wheel bore and wheel seat may result.

(13) To mount the opposite wheel, proceed in the same manner as stated above. Press the opposite wheel to a position of proper track gage. Standard track gage width of wheels is 56 1/2 inches, and back-to-back distance between wheels should be $53^{3}/8$ inches.

150. Thrust Collars

A thrust collar is mounted on each axle to take the side thrust of the motor bearings. It is mounted next to the inside face of the wheel on the commutator side of the axle. The collar is spaced from the wheel hub by spacer plugs, with the journal face adjacent to the motor bearing seat.

a. Removal. The collars are easily removed by pressing.

b. Mounting.

(1) Press the collars on the axle, using a pressing lubricant. The journal face must be adjacent to the motor bearing seat and not protruding over the shoulder radius, but tangent to it.

(2) After the wheels have been mounted, measure the distance between the wheel hub and back face of collar; then cut two spacer plugs proper length or place shims between plugs and collar. TACK WELD THE PLUGS TO THE COLLAR; NOT TO THE WHEEL HUB.

151. Flingers

a. Removal. Remove the flingers by holding a hot ring against them until they are expanded enough to be removed. They can also be pressed off, but care must be taken to avoid damage to the axle. These flingers are shrunk into place, therefore, there is no pressing lubricant between them and the axle.

b. Mounting.

(1) Place flingers in an oil bath and heat to 150° C.

(2) Remove flingers from oil bath and quickly slide them into place on the flinger seats of the axle, with the larger diameter flat side adjacent to the motor bearing seat.

(3) The distance from the flinger to the journal face of the thrust collar or to the journal face of the gear hub must be $6^{1}/8$ inches (fig. 44).

(4) It is suggested that gage blocks $6^{1}/8$ inches long be used for spacing the flingers.

152. Gears

a. Removal. Use a horizontal press to remove gears. Take precautions to protect the bearing seats.

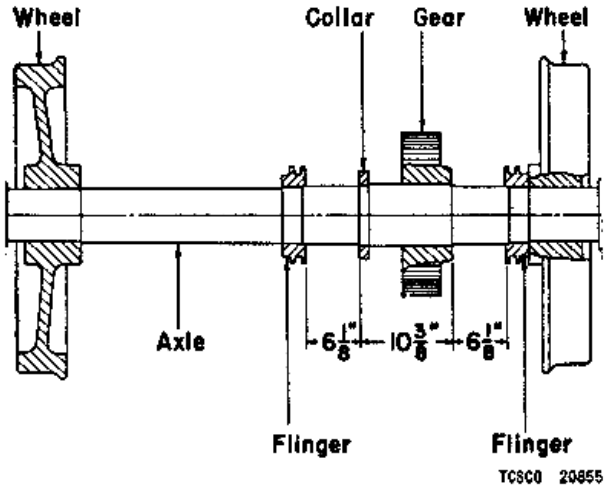


Figure 44. Wheels, axle and flingers, sectional view.

b. Mounting.

(1) The press-fit allowance should be 0.001 inch for each inch diameter of gear seat with a tolerance of +0.000 inch and -0.0015 inch. The mounting pressure should be 6 to 12 tons for each inch diameter of wheel seat.

(2) Coat the bore of the gear and the gear seat with pressing lubricant. The gear should be pressed on to a position where the journal face is adjacent and tangent to the radius on the motor bearing seat.

153. Axles

a. Description. These axles are forged carbon steel and have a smooth ground finish. The motor bearing seats are polished. The journal-bearing seats and end collars are polished to a journal finish. The axles are stamped with identification numbers and letters either on the ends of the axles or between the wheel seats. Do not remove or obliterate this identification. The information given on these axles is the type of steel, date of application, size of journal bearing, name of manufacturer, and serial number of axle.

b. Axle Turning. The wheel seats on axles should be turned only to remove scores or light surface cracks. Journal-bearing seats can also be turned or ground for the same purpose. After turning or grinding axles to remove surface cracks, it is advisable that they be subjected to a magna-flux or other magnetic-particle test before being put into service. The wheel seat should not be turned to a size to fit the wheel bore. The wheel should be bored to fit the axle.

c. Welding Axles. Do not attempt to patch cracks or build up worn away metal by welding. These axles are high carbon steel, therefore, applications of heat or welding will inevitably result in an axle failure.

d. Limits of Wear. The journal-bearing seat of the axle must not be worn or machined to a diameter one-half inch smaller than the original diameter. The end collar of the axle must not be worn or machined to a thickness of less than three-sixteenths inch when measured at a point one-fourth inch away from the surface of the journal-bearing seat.

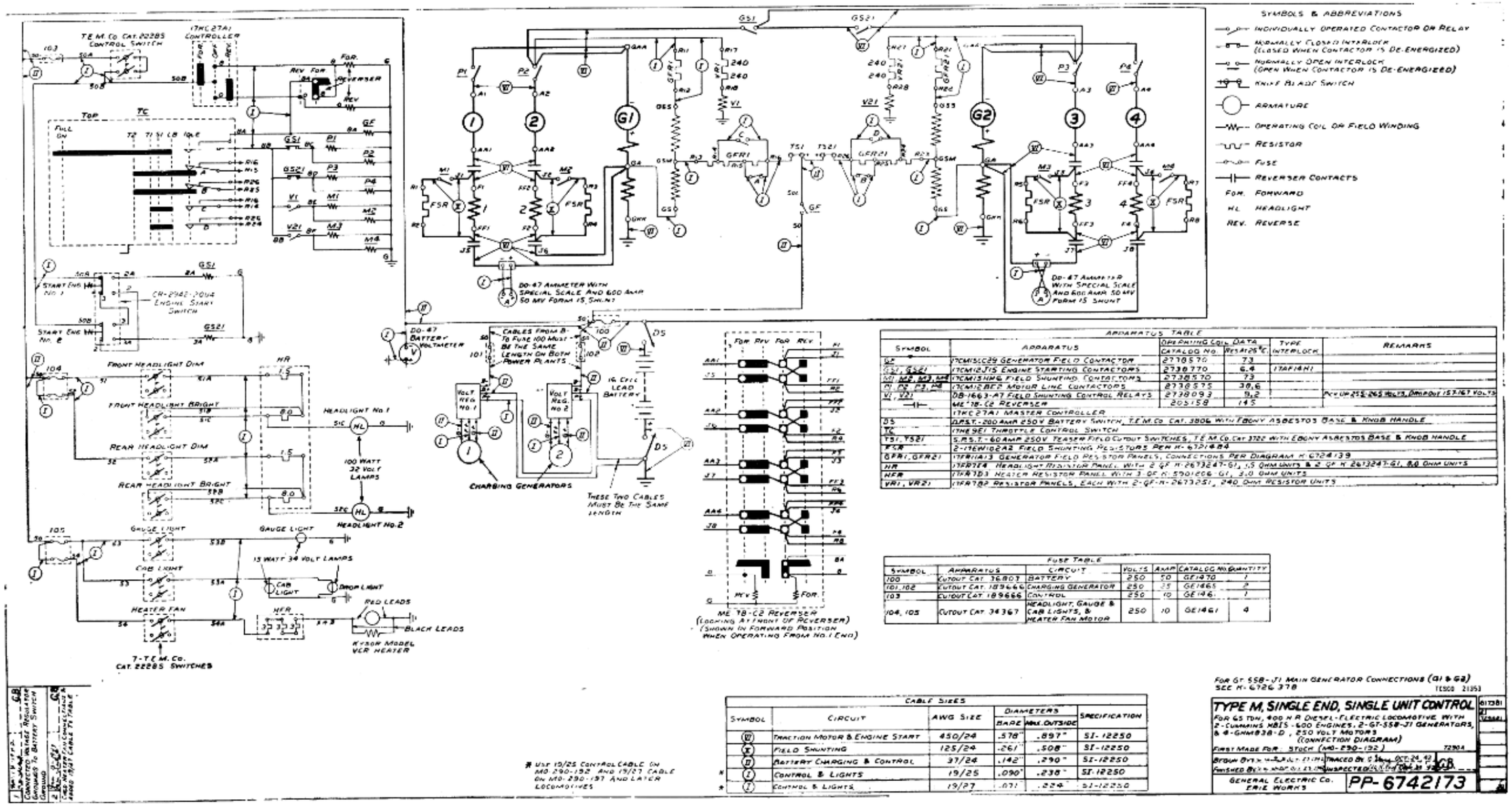


Figure 48. Locomotive connection diagram.

LUBRICATION ORDER
LC 19-100-CC-1

LO55-1001
24 March 1953

GENERATOR SET, DIESEL ENGINE-DRIVEN

(CUMMINS MODELS H, HI, HBI AND HBIS600)

References: TM55-1001, TM55-405

Intervals given are maximums for normal 8-hour day operation. For abnormal conditions or activities, intervals should be adjusted to compensate. Clean fittings before lubricating. Clean parts with SOLVENT, dry cleaning, or with OIL, Fuel, Diesel. Dry before lubricating.

Lubricate points indicated by dotted arrow shafts on both sides of the equipment. Drain crank and gear cases only when hot after operation; check level and replenish when cool.

LUBRICANT	•	INTERVAL
Fan Hub Bearings	BR	M
Water Pump Bearings	WP	M
Supercharger (Check and maintain level)	OE	W
Air Cleaner (Clean and refill)	OE	W
Charging Generator Coupling Chain	OE	W
Charging Generator Shaft Bearings	OE	2W
Generator Shaft Bearings (Maintain ½ full) (Clean and repack annually)	BR	S
Crankcase level (Check)		D
Crankcase Fill	OE	2W
Crankcase Drain (Drain)		2W

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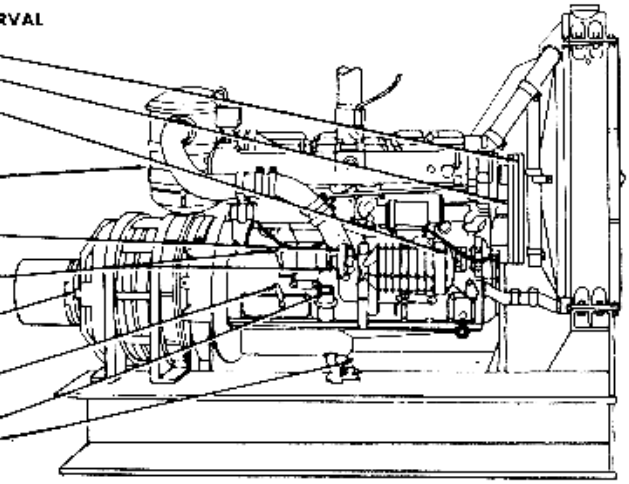

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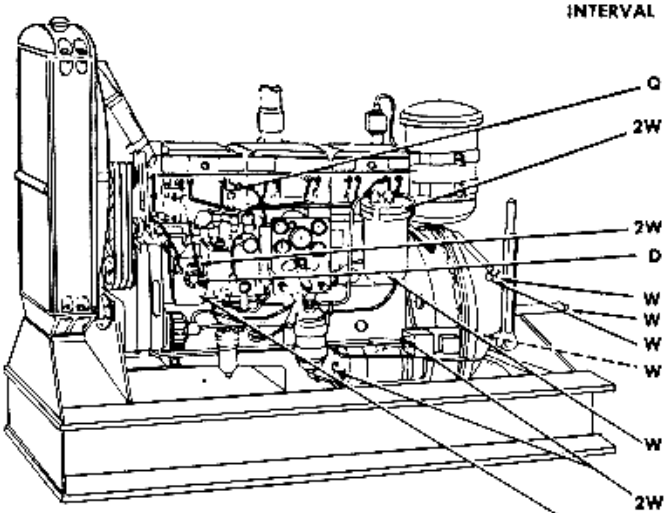

INTERVAL	•	LUBRICANT	
Q		GAA	Tachometer Drive & Adapter
2W			Lube Oil Filter (Clean and renew element)
2W		OE	Governor Fill
D			Governor Level (Check)
W		BR	Clutch Shaft Bearing
W		BR	Clutch Pilot Bearing
W		BR	Clutch Throwout Bearing
W		OE	Clutch Control Shaft Bearing
W			Lube Oil Filter Drain (Drain sludge)
2W		OE	Starting Motor Shaft Bearing
2W			Governor Drain (Drain and refill)

Figure 49. Department of the Army LO 55-1001.

LUBRICANTS	EXPECTED TEMPERATURE			
	Above 32"F.	+32 F To 0"F.	Below 0 F	INTERVALS
OE-OIL, engine, Heavy Duty	OE-30	OE-10	OE-10	D-Daily W-Weekly 2W-2 Weeks M –Monthly O -Quarterly (3 Months) S –Semiannually (6 Months)
GAA-GREASE, automotive and artillery	GAA	GAA	GAA	
WP-GREASE, lubricating, automotive and industrial (Water Pump)	WP	WP	WP	
BR-LUBRICANT, ball and roller bearing	BR	BR	BR	

-- NOTES --

Model HBIS-600 illustrated.
Lubrication points on all models are identical.

Copy of this lubrication order will remain with the equipment of all times; instructions contained herein ore mandatory and supersede all conflicting lubrication instructions dated ,error to the dote of this lubrication order

BY ORDER OF THE SECRETARIES OF THE ARMY AND THE AIR FORCE:

OFFICIAL:
WM. E. BERGIN
Major General, USA
The Adjutant General

J. LAWTON COLLINS
Chief of Staff,
United States Army

OFFICIAL:
K. E. THIEBAUD
Colonel, USAF
Air Adjutant General

HOYT S. VANDENBERG
Chief of Staff
United States Air Force

LUBRICATION ORDER
LC 58-5AA-9

LO55-1263
18 March 1953

LOCOMOTIVE, DIESEL-ELECTRIC
(GENERAL ELECTRIC — 65 TON, ENGINE — CUMMINS MODEL HB1S-600)

Reference: TC 7, 8 & 9 L-37, TM 55-1263

Intervals given are maximums for normal 8-hour day operation. For abnormal conditions or activities, intervals should be adjusted to compensate.

Clean fittings before lubricating.

Clean parts with SOLVENT, dry cleaning, or with OIL, fuel, Diesel. Dry before lubricating.

Lubricate points indicated by dotted arrow shafts on both sides of the equipment.

Drain crank and gear cases only when hot after operation; Check level and replenish when cool.

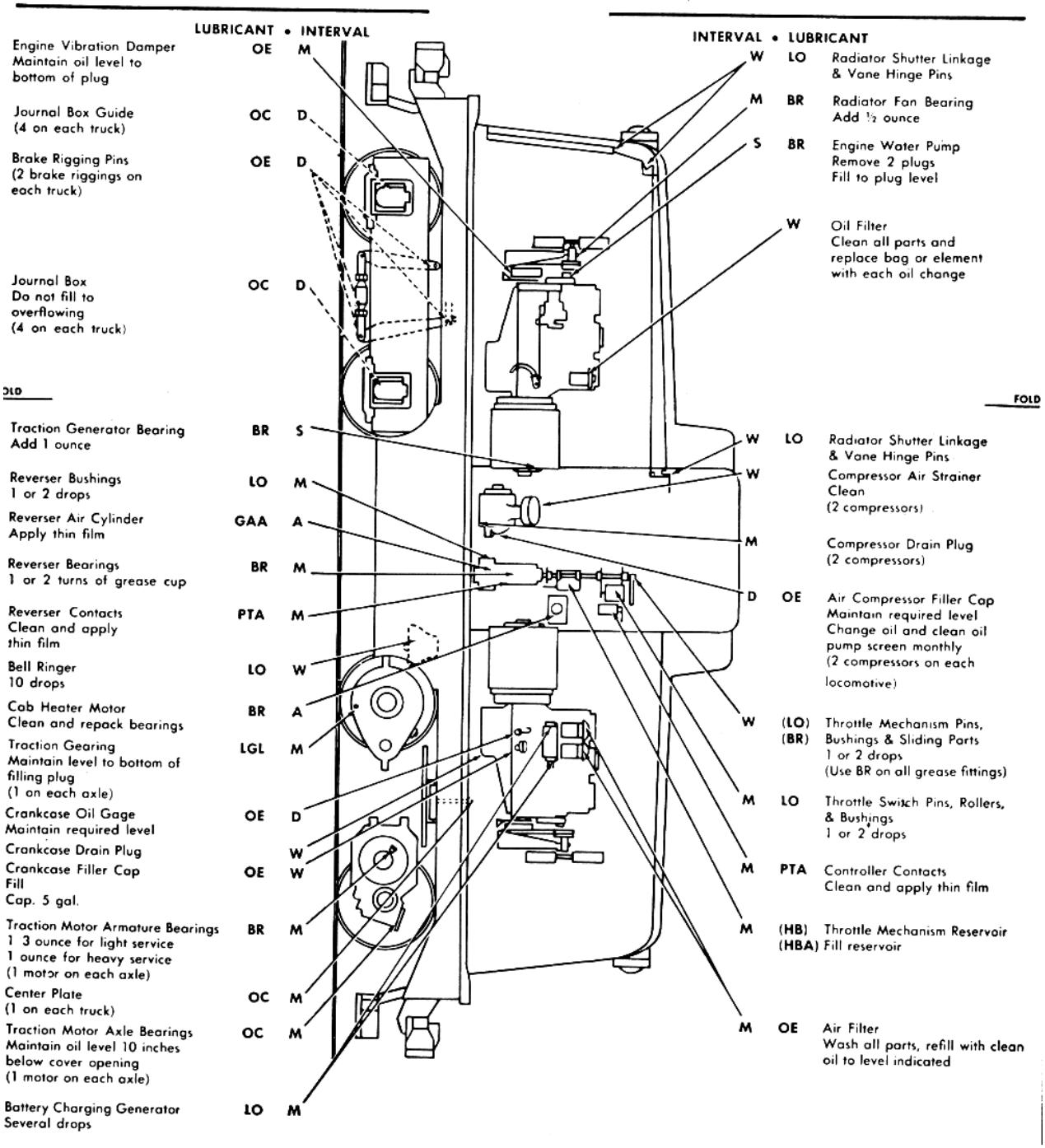

Figure 50. Department of the Army LO 55-1268.

--- KEY ----

	EXPECTED TEMPERATURES			INTERVALS
LUBRICANTS	Above 32 F.	32 F. To 0 F.	Below 0 F.	
OE-OIL, engine	OE 30	OE 10	OE 10	
LGL--LUBRICANT, gear, locomotive traction motor	LGLA	LGL-2	LGL-2	
GAA-GREASE, automotive and artillery	GAA	GAA	GAA	D-Daily W-Weekly M –Monthly S-Semiannually (6 months) A-Annually (12 months)
BR--LUBRICANT, ball and roller bearing	BR	BR	BR	
HB-FLUID, hydraulic brake	HB	I	HBA	
OC-OIL, lubricating, car and locomotive engine	OC	OC	OC	
LO-OIL, lubricating, light	LO	LO	LO	
PTA-PETROLATUM, (aeronautical)	PTA	PTA	PTA	
HBA-FLUID, hydraulic brake, arctic				

Copy of this lubrication order will remain with the equipment at all times; instructions contained herein are mandatory and supersede all conflicting lubrication *instructions* dated prior to the date of this lubrication order.

BY ORDER OF THE SECRETARIES OF THE ARMY AND THE AIR FORCE:

OFFICIAL:

WM. E. BERGIN
Major General, USA
The Adjutant General

J. LAWTON COLLINS
Chief of Staff,
United States Army

OFFICIAL:

K. E. THIEBAUD

Air Adjutant General

HOYT S. VANDENBERG Colonel, USAF
Chief of Staff,
United States Air Force

INDEX

	Paragraph	Page
Air brake, operation	23	9
Air compressor, lubrication	51	14
Anti sleeve device	140	68
Auxiliary equipment	25	9
Axles	153	75
Battery:		
Cleaning	119	62
Instructions	6	6
Points	121	62
Reading and records	117	61
Switch	7	6
Specific gravity	120	62
Water	118	62
Battery charging:		
Equipment	27	10
Regulator settings	116	61
Brake cylinder, lubrication	54	15
Brake, general	13	7
Brake rigging	137	66
Brake valve, lubrication	53	14
Center plates:		
Lubrication	57	16
Maintenance	145	71
Component data	5	4
Contactors:		
General	100	51
Maintenance data	101	52
Controller type 17KC27A1	95	43
Controls:		
Equipment	43	13
Lubrication	52	14
Controls switch:		
Battery	8	6
Type 17HE9E1	104	53
Couplers and draft gear	138	67
Dead movement of locomotive	24	9
Description, general	4	4
Electrical equipment, maintenance	42	13
Engine:		
Failure to turn over	33	10
Lubrication	48	14
Operation, preliminary	12	7
Started, locomotive does not move in first throttle position	34	10
Starting equipment	28	10
Flingers	151	74
Forms and records	3	3
Gears	152	74
Generator, main:		
Characteristics	68	20
Fields	31	10
Lubrication	49	14
Maintenance data	80	34
Hand brakes	136	66
Heater:		
Care of wick	126	63
Cleaning	130	65
Cleaning wicks	127	63
Fuel	123	63
How to extinguish	125	63
How to light	124	63
Not in use	131	65
Rewicking	129	64
Setting wicks	122	62
Sticking wicks	128	64
Hydraulic system:		
Air in	64	19
Leak in	65	19
Venting	66	19
Hydraulic throttle	63	17
Idling adjustment	67	20
Inspection:		
Before leaving terminal	37	11
Greater than monthly	41	12
Routine	35	11
When returning to terminal	38	11
160 locomotive hours or weekly	39	11
680 locomotive hours or monthly	40	12
Instruments	106	54
Interlocks	102	52
Journal boxes:		
Maintenance, removing trucks	148	72
Maintenance, not removing trucks	134	65
Journal main	55	15
Leaving locomotive	14	7
Load indicator	10	6
Lubrication:		
Engine	16	7
Inspection	36	11
Magnet valves:		
General care	98	47
Maintenance data	99	51
Main circuits	30	10
Motor:		
Axle mountings	147	72
Lube	50	14
Suspensions	142	68
Wheel axle assemblies	146	71

	Paragraph	Page
Mounting engine and generator	45	14
Operation, general	19	8
Overheating of engines	20	9
Pedestal and journal box wear plates	135	66
Power, how obtained	29	10
Power plant:		
Description	61	17
Operation	62	17
Operation, (one cut out)	21	9
Test partial throttle	69	23
Precautions	32	10
References	2	3
Regulator adjustments	115	59
Relay	103	53
Resistors	105	53
Reverser:		
General	96	43
Maintenance data	97	47
Running gear	44	13
Side bearings	139	67
Speed operating	11	7
Springs and equalizers	141	68
Starting generator:		
Characteristics	107	55
Commutator maintenance	109	55
Control unit:		
Adjustments	114	59
Characteristics	113	59
Inspection	112	51
Disassembly	110	55
Inspection	108	55
Reassembly	111	57
Starting power plant	17	8
Stopping engines	18	8
Temperature control	26	9
Tests:		
General	58	16
Preparation	59	16
Throttle handle	9	6
Thrust collar	150	74
Traction generator:		
Care and maintenance	75	26
Cleaning	73	26
Description	70	25
Disassembly	74	26
Inspection	72	25
Inspection after repairs	78	34
Reassembly	76	32
Testing after repairs	77	32
Traction motor:		
Armature removal	89	41
Armature repair	93	42
Brushholder, brushes and commutators	86	39
Cut out	22	9
Gear cover	85	38
Gear lube	56	16
General	81	35
Inspection	83	37
Lubrication	82	35
Maintenance data	94	43
Overhauling	92	41
Pinion assembly	88	39
Pinion removal	87	39
Reassembly	91	41
Repack bearings	84	38
Removal of pinion end frame end from Armature	90	41
Trouble, locating	79	34
Truck and running gear, description	132	65
Truck, general	144	70
Truck repairs:		
Not requiring removal	153	75
Requiring removal	143	69
Ventilation	71	25
Voltage test application	60	16
Water and lube oil	15	7
Water cooling system	46	14
Wheels:		
Diameter	47	14
General	149	73

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